Clinical Forensic Medicine

A Physician's Guide

Margaret M. Stark
Editor

Fourth Edition

Springer

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Clinical Forensic Medicine: History and Development

1

J. Jason Payne-James and Margaret M. Stark

Learning Objectives

To describe the recent developments in the field of forensic and legal medicine.

To discuss the roles of the healthcare professional in general forensic medicine and sexual offence medicine.

Introduction

The term "forensic medicine" is now used to embrace all aspects of forensic work of a medical nature. In the past, the term was often used interchangeably with "forensic pathology"—the branch of medicine which investigates death. This is further confounded by the recognition of 'forensic & legal medicine' or 'legal and forensic medicine' as distinct areas of medical specialty practice. These terms now broadly embrace all aspects of medicine involving justice systems, and can vary around the world. The term "clinical forensic medicine" is however one that can be properly applied to that part of medical practice whose scope involves interaction between the law, the judiciary, and the police involving (generally) living persons.

Clinical forensic medicine is a term that has become widely used only in the last four decades or so, although the phrase has been used at least since 1951 in the UK, when the national Association of Police Surgeons (which became the Association of Forensic Physicians in 2003 until it in turn was replaced by the Faculty of Forensic & Legal Medicine of the Royal College of Physicians of London) was first established.

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The absence of a defined medical specialty of clinical forensic medicine has resulted in practitioners of clinical forensic medicine having different descriptive names over the years. The term “forensic physician” (FP) is now widely accepted internationally, although police surgeon, divisional surgeon, forensic medical officer (FMO) and forensic medical examiner (FME) are examples of other names or titles that have been used to describe those who practice in the specialty of clinical forensic medicine. Such names refer more to the appointed role than to the work done. Worldwide, there are many who are involved in both clinical and pathological aspects of forensic medicine, and increasing allied healthcare professionals (HCPs), such as nurses and paramedics, may play a role in the delivery of clinical forensic medicine.

Generally, however, a forensic pathologist does not deal predominantly with living individuals, and an FP does not deal with predominantly with the deceased. However there is substantial overlap in the clinical and pathological aspects of forensic medicine and the forensic sciences, and this is reflected in the history and development of the specialty as a whole and its current practice and literature today [1, 2].

Table 1.1 gives examples of roles that any HCP/FP may be asked to undertake in the UK [3]. The Table also includes examples of additional roles that more senior and experienced FPs may undertake. Some HCPs may only perform some of these roles—for example, focusing on general forensic medicine (GFM, custodial medicine) alone, or sexual offence medicine (SOM) alone, or child maltreatment, whereas others may play a more extended role, depending on geographic location (in terms of country and state), local statute and judicial systems. HCPs/FPs should have a good knowledge of medical jurisprudence—the application of medical science to the law within their own jurisdiction. The role and scope of the specialty of clinical forensic medicine remain ill-defined in global terms, unlike other established medical specialties such as gastroenterology, emergency medicine or cardiology. Often doctors practicing clinical forensic medicine may only take on these functions as subspecialties within their own general workload. Pediatricians, emergency medicine specialists, primary care physicians, psychiatrists, gynecologists and genitourinary medicine specialists are those who frequently have a part-time role as FPs and such work is commonly a feature of the increasing numbers of medical practitioners with portfolio careers.

Historical References

The origins of clinical forensic medicine go back millenia, and as Smith concluded in 1951 “forensic medicine [cannot be thought of] as an entity … until a stage of civilization is reached in which we have … a recognizable legal system … and an integrated body of medical knowledge and opinion” [4].

Forensic medicine developed in a number of jurisdictions in parallel and there is dispute as to when medical expertise in the determination of legal issues was first used. It is generally accepted that one of the earliest examples is that identified by Chinese archaeologists who (in 1975) discovered a number of bamboo pieces dating from about 220 BC (Qin dynasty) with rules and regulations for examining injuries

Table 1.1 Roles of an independent forensic physician [adapted from reference 3]

Part A
Specific functions
Detainee examinations: Custody officers (police officers tasked with the responsibility of welfare of detainees) are obliged to call an appropriately trained health care professional (HCP) when they suspect, or are aware of, any physical illness, mental health problem, or injury of the detainee. The HCP in attendance is responsible for the clinical needs of a detainee and should also consider their well-being (food, drink, rest, warmth etc.).
The HCP is often requested to provide an opinion on one or more of the following:
• Fitness to be detained in police custody (e.g. assessment of diabetic control, requirement for medication, referral to hospital)
• Fitness to be released (e.g. consideration of the medical and physical fitness to release safely, consideration of any risk to public safety, or the personal well-being of the detainee where there are suicidal thoughts or other vulnerabilities, pre-release risk assessment)
• Fitness to be charged (e.g. competent to comprehend charge, assessing mental capacity or vulnerability)
• Fitness to transfer, (e.g. when wanted on warrant elsewhere, possibly necessitating a long journey, or fitness to fly)
• Fitness to be interviewed by the police (see Chap. 11)
• Requirement of an appropriate adult (an appropriate adult in England & Wales law is someone tasked to support those with vulnerabilities—e.g. due to age, mental health conditions), support person, interview friend
• Assessment and management of alcohol and drug intoxication and withdrawal • Attendance at the hospital to take samples under the Road Traffic Act or where patients have been seriously assaulted
• Assess those detained under Road Traffic Act legislation (e.g. determining whether there is a "condition…might be due to a drug")
• Undertake intimate body searches for drugs or weapons (with consent and on premises with appropriate medical and resuscitation support) • Assessment of individuals subjected to restraint, including irritant sprays, batons, handcuffs, etc.
Detainee and complaint examinations:
The HCP is expected to
• Ensure the safeguarding of vulnerable adults and children, and to comply with safeguarding principles
• Put in place appropriate treatment/referral, including for emergency contraception, post-exposure prophylaxis and sexually transmitted infection (STI) screening
• Accurately assess, document (and with appropriate training interpret) injuries
• Take relevant forensic samples appropriate to police investigations
• Examine and treat police officers injured while on duty (e.g. needle stick injuries and other at-risk exposure)
• Confirm life extinct at a scene of death and give a preliminary opinion on whether there are any suspicious circumstances
• Give an opinion at certain scenes in relation to bony remains (e.g. are they human)
• Give advice to the police when requested
• Undertake mental state examinations

(continued)

Table 1.1 (continued)

In addition, HCPs with sufficient training and experience may be requested to
• Examine adult complainants of serious sexual assault and the suspects
• Examine alleged child victims of neglect, physical or sexual abuse (doctors only)
• Conduct formal mental health assessments under the Mental Health Act (doctors only)
• Examine those detained under terrorism legislation and be responsible for leading a multidisciplinary team and setting a management plan (doctors only) • Assess a detainee who has been subjected to a conducted electrical weapon (CEW e.g. TASER®)
Part B
Senior forensic physicians and those with particular skills may also have other broad roles including:
Giving expert opinion in courts and tribunals
Death in custody investigation Assessments related to: • Victim of torture or cruel inhumane and degrading treatment • War crimes e.g. the physical capability of an individual to withstand trial • Female genital mutilation • Refugee medicine medical and forensic issues • Asylum seeker medicine medical and forensic issues
For all the examinations outlined above it is essential that the HCP accurately documents findings and when needed produce these as written reports for appropriate civil, criminal, coronial courts or other agencies such as disciplinary tribunals. The HCP must be able to present the information orally, clearly and concisely to a court, tribunal or other forum.

inscribed on them. Other historical examples of the link between medicine and the law can be found around the world. In the English language, the specific terms *forensic medicine* and *medical jurisprudence* (also referred to as juridical medicine) date back to the early nineteenth century. In 1840, Thomas Stuart Traill [5] made reference to the connection between medicine and legislation and stated “it is known in Germany….by the name of State Medicine, in Italy and France it is termed Legal Medicine; and with us [in the United Kingdom] it is usually denominated Medical Jurisprudence or Forensic Medicine”.

Amundsen and Ferngren [6] in studies of physicians in legal settings concluded that forensic medicine was used by Athenian courts and other public bodies and that the testimony of physicians in matters of a medical nature was given particular credence although this use of physicians as expert witnesses was “loose and ill-defined” [7]. In the Roman Republic, the “Lex Duodecim Tabularum” (laws drafted on 12 tablets and accepted as a single statute in 449 BC) had minor references to medico-legal matters, including length of gestation (to determine legitimacy), disposal of the dead, punishments dependent on the degree of injury caused by an assailant, and poisoning [8]. Papyri related to Roman Egypt dating from the latter part of the first to the latter part of the fourth century AD contain information about forensic medical examinations or investigations [9].

The evidence for a relationship between medicine and the law in these periods is undoubted, but the specific definition and role of forensic medicine, as interpreted by historical documents, is imprecise, with the degree and extent of forensic medical input acknowledged depending on the particular historian undertaking the assessment or review.

A specific role for the medical expert as a provider of impartial opinion for the judicial system appears to be identified clearly by the Justinian Laws between 529 and 564 AD. Traill [5] stated that "Medical Jurisprudence as a science cannot date farther back than the 16th century". He identified George, Bishop of Bamberg, who proclaimed a penal code in 1507, as the originator of the first codes in which medical evidence was a necessity in certain cases. The "Constitutio Criminalis Carolina", the code of law published and proclaimed in 1553 in Germany by Emperor Charles V, is considered by many to have formed the origin of Legal Medicine as a specialty: expert medical testimony became a requirement rather than an option in cases of serious crime such as murder, wounding, poisoning, hanging, drowning, infanticide and abortion. Medico-legal autopsies were well documented in parts of Italy and Germany five centuries before the use of such procedures by English coroners. The use of such expertise was not limited to deaths or to mainland Europe. Cassar [10], for example, describes the earliest recorded Maltese medico-legal report (1542): medical evidence established that the male partner was incapable of sexual intercourse and this resulted in a marriage annulment. Beck [11] identifies Fortunatus Fidelis as the earliest writer on medical jurisprudence—with his "De Relationibus Medicorum" which was published in Palermo, Italy in 1602. Subsequently Paulus Zacchias wrote "Quaestiones Medico-Legales" described by Beck as "his great work" between 1621 and 1635 and a facsimile version of that is still available (Fig. 1.1). Beck also refers to the

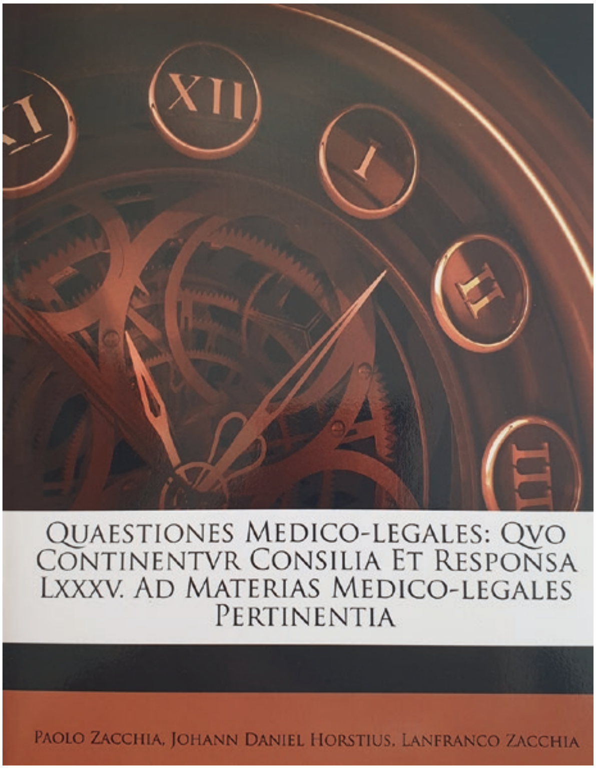


Fig. 1.1 Quaestiones Medico-Legales

Pandects of Valentini published in Germany in 1702 which he describes as “an extensive retrospect of the opinions and decisions of preceding writers on legal medicine”. In France in 1796 Fodere published the first edition in three octavo volumes of his work “Les Lois E’clairees par les Sciences Physique, ou Traite de Medicine Legale et d’Hygiene Publique”.

Late Eighteenth Century Onwards

From the latter part of the eighteenth century, a number of books and treatises were published in the English language on the topics of forensic medicine and medical jurisprudence. What is remarkable is that the issues and subjects addressed by many of the authors remain current today, and often the principles remain unchanged. Table 1.2 shows the Table of Contents of John Gordon Smith’s book (“The Principles of Forensic Medicine: Systematically Arranged”) in 1821 [12] (see Fig. 1.2a–d).

In 1783 William Hunter [13] published an essay “On the Uncertainty of the Signs of Murder in the Case of Bastard Children”; this may well be the first true “forensic medicine” publication from England. The first large work was published in 1788 by Samuel Farr. John Gordon Smith writes in 1821 in the Preface to his own book [12] “The earliest production in this country, professing to treat of Medical Jurisprudence *generaliter* was an abstract from a foreign work, comprised in a very small space”. It bears the name of “Dr Farr’s Elements, &c and first appeared above thirty years ago”. In fact that publication was translated from the 1767 publication Elemental Medicinae Forensis by Fazelius of Geneva. Davis [14] refers to these and to Remarks on Medical Jurisprudence by William Dease of Dublin, as well as the Treatise on Forensic Medicine or Medical Jurisprudence by O. W. Bartley of Bristol. Davis considered however that the “first original and satisfactory work” was George Male’s Epitome of Juridical or Forensic Medicine, published in 1816. Male was a physician at Birmingham General Hospital and is often considered the father of English Medical Jurisprudence. Smith refers also to Male’s book but also comments “to which if I may add a ‘Treatise on Medical Police’, by John Roberton, MD”.

Texts on forensic medicine began to appear more rapidly and with much broader content. John Gordon Smith [12] stated that “Forensic Medicine—Legal, Judiciary or Juridical Medicine—and Medical Jurisprudence are synonymous terms”. Having referred in the Preface to the earlier books, he notes, “It is but justice to mention that the American schools have outstripped us in attention to Forensic Medicine”. By this he was probably referring in part to the writing of Theodric Romeyn Beck and others. Beck published the first American textbook 2 years later in 1823 and a third (London) edition had been published by 1829 [11]. Prior to this, in 1804 J. A. Stringham, who was trained in Edinburgh being awarded an MD in 1799, was appointed as a Professor in Medical Jurisprudence at the College of Physicians and Surgeons of New York and given a Chair in 1813.

John Gordon Smith [12] wrote that “Every medical practitioner being liable to a subpoena, should make it his business to know the relations of physiological and pathological principles to the facts on which he is likely to be interrogated, and

Table 1.2 Chapter contents of John Gordon Smith's 1821 "The principles of forensic medicine; systematically arranged"

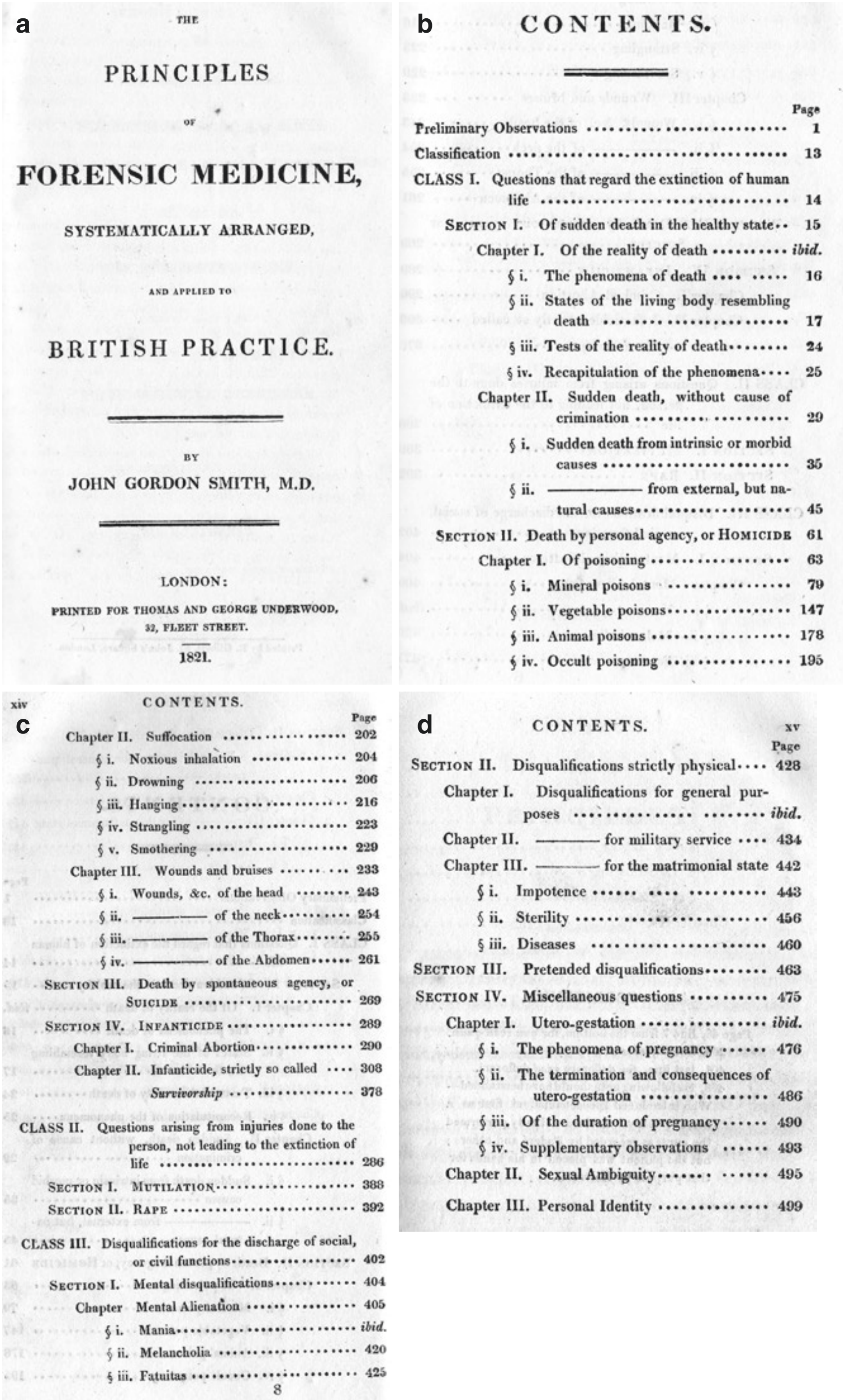
Class I: Questions that regard the extinction of human life	
Section 1	Of sudden death in the healthy state
	Chapter 1
	Of the reality of death
	The phenomena of death
	States of the living body resembling death
	Tests of the reality of death
	Recapitulation of the phenomena
	Chapter 2
	Sudden death, without cause of crimination
	Sudden death from intrinsic or morbid causes
	Sudden death from external, but natural causes
Section 2	Death by personal agency or homicide
	Chapter 1
	Of poisoning
	Mineral poisons
	Vegetable poisons
	Animal poisons
	Occult poisoning
	Chapter 2
	Suffocation
	Noxious inhalation
	Drowning
	Hanging
	Strangling
	Smothering
	Chapter 3

(continued)

Table 1.2 (continued)

	Wounds and bruises
	Wounds etc. of the head
	Wounds of the neck
	Wounds of the thorax
	Wounds of the abdomen
Section 3	Death by spontaneous agency, or suicide
Section 4	Infanticide
	Chapter 1
	Criminal abortion
	Chapter 2
	Infanticide, strictly so called
	Survivorship
Class 2: Questions arising from injuries done to the person, not leading to the extinction of life	
Section 1	Mutilation
Section 2	Rape
Class 3: Disqualification for the discharge of social or civil functions	
Section 1	Mental disqualification
	Chapter
	Mental alienation
	Mania
	Melancholia
	Fatuitas
Section 2	Disqualifications strictly physical
	Chapter 1
	Disqualifications for general purposes
	Chapter 2
	Disqualifications for military service

	Chapter 3
	Disqualifications for the matrimonial state
	Impotence
	Sterility
	Diseases
Section 3	Pretended disqualifications
Section 4	Miscellaneous questions
	Chapter 1
	Utero-gestation
	The phenomena of pregnancy
	The termination and consequences of utero-gestation
	Of the duration of pregnancy
	Supplementary observations
	Chapter 2
	Sexual ambiguity
	Chapter 3
	Personal identity



a

THE

PRINCIPLES

OF

FORENSIC MEDICINE,

SYSTEMATICALLY ARRANGED,

AND APPLIED TO

BRITISH PRACTICE.

BY

JOHN GORDON SMITH, M.D.

LONDON:

PRINTED FOR THOMAS AND GEORGE UNDERWOOD, 32, FLEET STREET.

1821.

b

CONTENTS.

c

xiv CONTENTS.

8

d

CONTENTS. xv

Fig. 1.2 Publication details and sample chapter contents from John Gordon Smith's 1821 book Forensic Medicine likewise the principal judiciary bearings of the case. The former of these are to be found in works on Forensic Medicine; the latter in those on Jurisprudence". Alfred Taylor [15] in "A Manual of Medical Jurisprudence" defined medical jurisprudence as "…that science, which teaches the application of every branch of medical knowledge to the purpose of law".

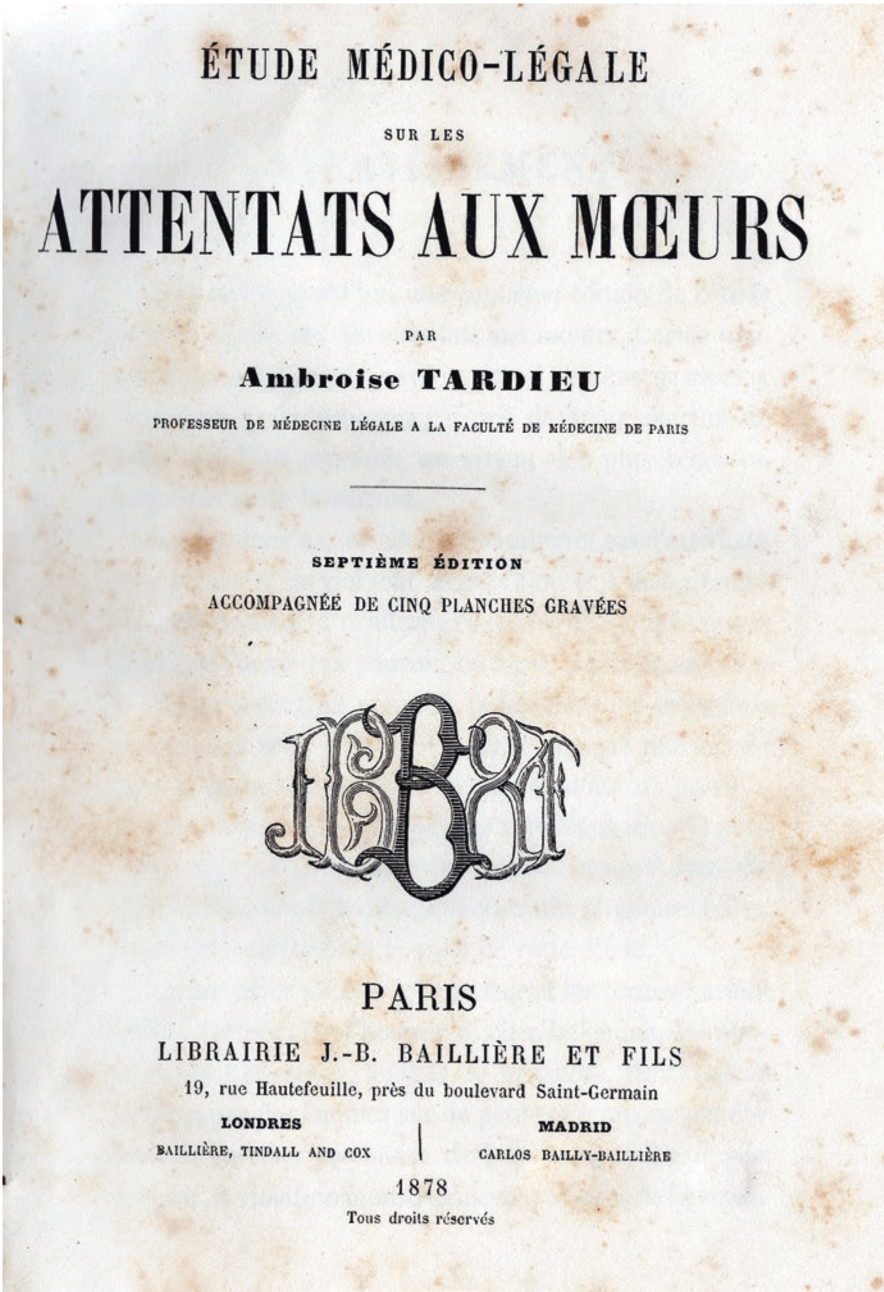
There was a clear demand for such books and Traill initially published in 1834 [16] and subsequently in 1840 [5] when Regius Professor of Jurisprudence and Medical Police at Edinburgh an "Outlines of a Course of Lectures on Medical Jurisprudence". The first Chair of Forensic Medicine had been established in the UK in Edinburgh in 1803—the appointee being Andrew Duncan, Junior, (although Andrew Duncan Senior had lectured there on forensic medicine topics since 1789 [17]). Subsequent non-professorial academic forensic medicine posts were set up at Guy's Hospital and Charing Cross Hospital, London. "Principles of Forensic Medicine" by William Guy [18], Professor of Forensic Medicine at King's College, London was published in 1844. At a similar period (in 1839 and 1875 respectively), academic chairs of medical jurisprudence were created in Glasgow and Aberdeen [19] emphasizing the importance of Scottish universities to the development and awareness of forensic medicine and medical jurisprudence.

Over these periods, the relevant areas of interest to forensic medicine and medical jurisprudence were gradually becoming much better defined across Europe and an increasing number of textbooks were being published by those prominent in the field (e.g. those of Tardieu—see Fig. 1.3). Thus, by the end of the nineteenth century, a framework of forensic medicine that persists today had been established in Europe, the UK, America, and related jurisdictions.

Contemporary Clinical Forensic Medicine

The following working definition has been suggested as embracing all relevant aspects: "…clinical forensic medicine includes all medical [healthcare] fields which may relate to legal, judicial and police systems" [20]. Previously although medicine and law interact much more frequently in cases of living individuals, forensic pathology was considered as the academic basis for forensic medicine. In recent years it is clear that as the broad clinical and pathological nature of 'forensic medicine' has been redefined, that research and academic interest in clinical forensic medicine is an area of much more focused and extensive research.

This has been helped by much greater awareness of abuses of human rights and civil liberties, and the particular role that those practicing clinical forensic medicine play in the conditions of detention of prisoners and in the application of justice to both complainant and suspect. The care of detainees is one of the major difference in roles between HCPs and forensic pathologists, and a number of bodies nationally and internationally have reinforced the duties of doctors involved with detainees in this setting, variously emphasizing the duties of consent and confidentiality, and their responsibilities to the individual (not the state, or government or body for whom they may be acting or employed by). Publications are now available that directly address


ÉTUDE MÉDICO-LÉGALE

SUR LES

ATTENTATS AUX MŒURS

PAR

Ambroise TARDIEU

PROFESSEUR DE MÉDECINE LÉGALE A LA FACULTÉ DE MÉDECINE DE PARIS

SEPTIÈME ÉDITION

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BAILLIÈRE, TINDALL AND COX

MADRID

CARLOS BAILLY-BAILLIÈRE

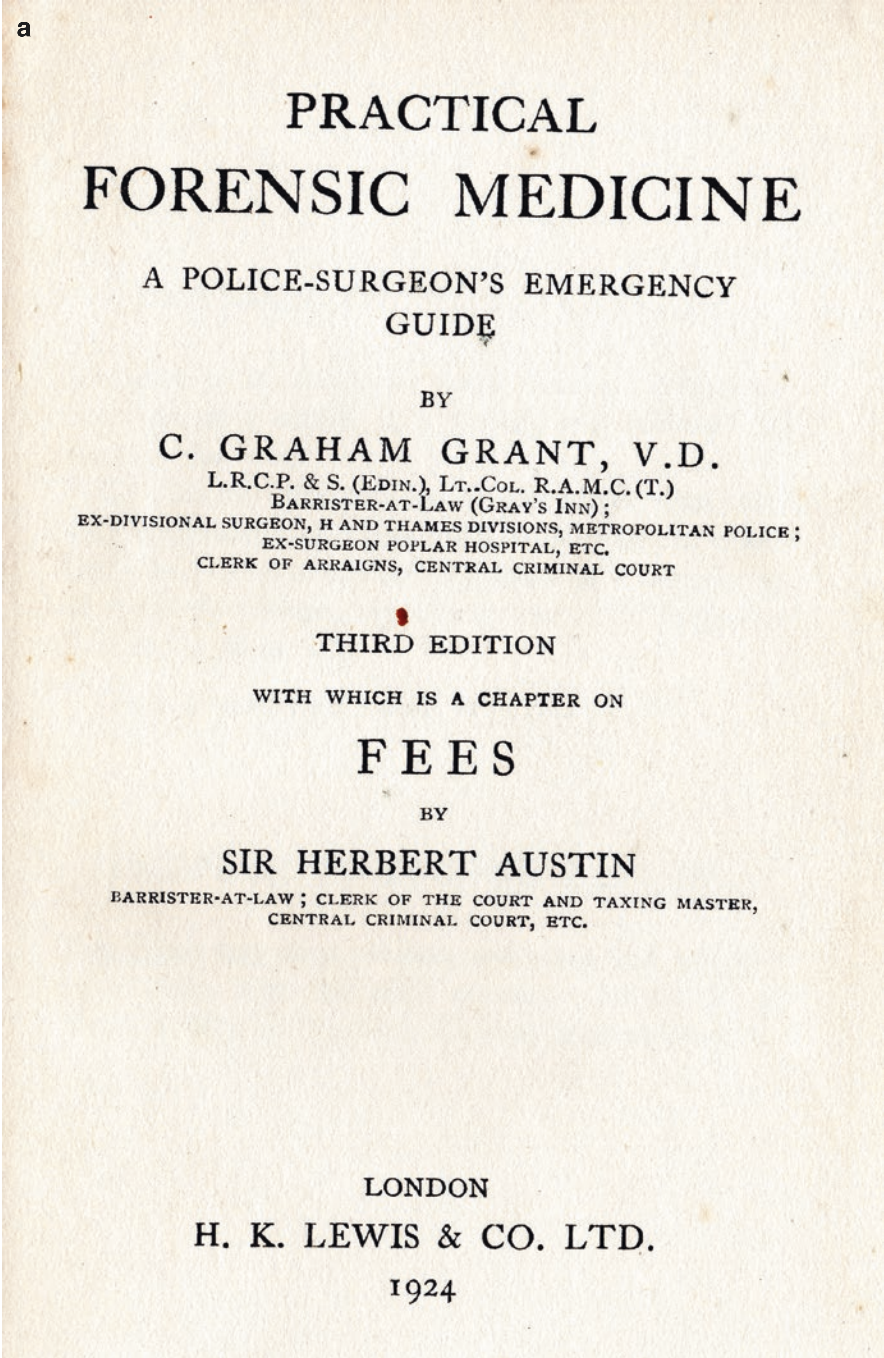
1878

Tous droits réservés

Fig. 1.3 Publication details of Ambroise Tardieu's 1878 edition of Attentat Aux Moeuers the principles behind and the nature and delivery of such care [21–25], which may address broad principles from a national and international statutory basis, and provided specific guidelines on expected standards on a national and regional basis. There are many examples of injustice as a result of doctors and other healthcare professionals unaware of or failing to observe basic human rights or rights enshrined in statute. Such lack of knowledge or failure of medical professionals may be considered at least poor performance and at worst criminally negligent. High profile older cases such as the death of Steve Biko in South Africa, the conviction of Carole Richardson in England and the deaths of indigenous Australians in prisons are examples of many more injustices and inequalities. The potential conflicting needs and duties of those working in the judicial system are now well recognized, and it is difficult for any healthcare professional working in places of detention or others similar settings to claim that they are unaware of their professional, medical and ethical duties. In England and Wales, the Human Rights Act 1998—enacted in 2000—whose purpose is to make it unlawful for any public authority to act in a manner incompatible with a right defined by the European Convention of Human Rights—reinforced the need for doctors to be very aware of those human rights issues that touch on prisoners and that doctors can influence. It is worth noting that it took more than half a century after publication of the European Convention of Human Rights and Fundamental Freedoms for that law to be enacted in England and Wales.

The HCP has a number of roles that may interplay when assessing a prisoner or someone detained by the state or other statutory body. Three facets of medical care that may conflict have been identified: first, the role of medico-legal expert for a law enforcement agency; second, the role of a treating doctor; and third, the examination and treatment of detainees who allege that they have been mistreated by the police during their arrest, during interrogation or during the various stages of police custody [26]. This conflict is well recognized and not a new concept for HCPs. Grant [27] was a police surgeon appointed to the Metropolitan Police in the East End of London, UK, in September 1897, and recorded the following incident: “One night I was called to Shadwell [police] station to see a man charged with being drunk and disorderly, who had a number of wounds on the top of his head … I dressed them] … and when I finished he whispered ‘Doctor, you might come with me to the cell door’ … I went with him. We were just passing the door of an empty cell, when a police constable with a mop slipped out and struck the man a blow over the head … Boiling over with indignation I hurried to the Inspector’s Office [and] told him what had occurred”. Dr. Grant records that the offender was dealt with immediately. Dr. Grant clearly perceived that he had moral, ethical and medical duties to his patient, who was in this case the prisoner. Figure 1.4a, b show extracts from one of his publications [27] and shows that he (as a doctor) was clear about some basic principles, that may be considered still relevant today.

Dr. Grant was one of the pioneering “police surgeons” in England, the first “Superintending Surgeon” having been appointed to the Metropolitan Police



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PRACTICAL
FORENSIC MEDICINE

A POLICE-SURGEON'S EMERGENCY GUIDE

BY

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CLERK OF ARRAIGNS, CENTRAL CRIMINAL COURT

THIRD EDITION

WITH WHICH IS A CHAPTER ON

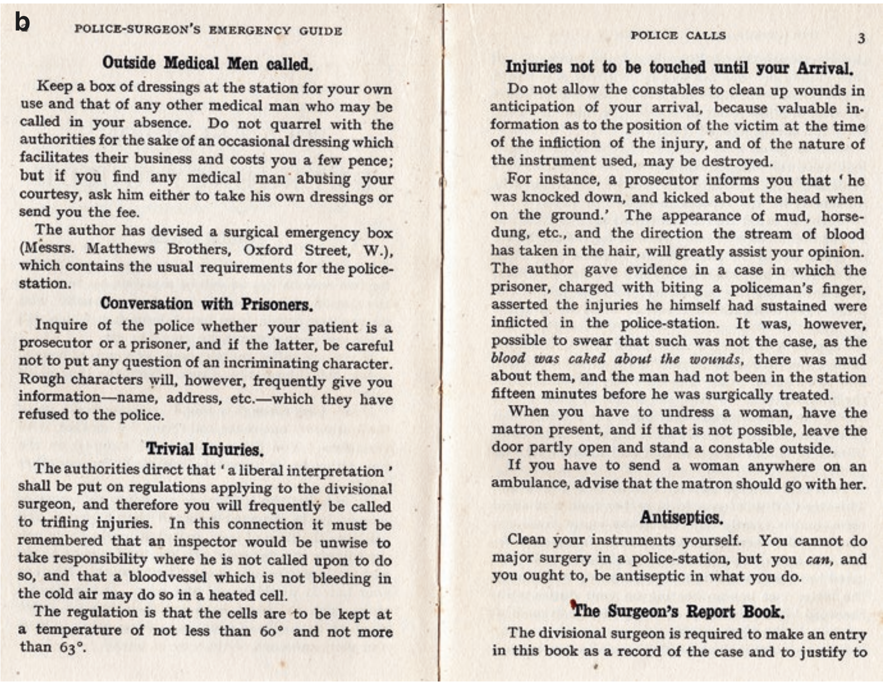
FEES

BY

SIR HERBERT AUSTIN
BARRISTER-AT-LAW; CLERK OF THE COURT AND TAXING MASTER,
CENTRAL CRIMINAL COURT, ETC.

LONDON
H. K. LEWIS & CO. LTD.
1924

Fig. 1.4 Publications and sample pages from C Graham Grant's 1924 book - Practical Forensic Medicine - A Police Surgeon's Emergency Guide



b

POLICE-SURGEON'S EMERGENCY GUIDE

Outside Medical Men called.

Keep a box of dressings at the station for your own use and that of any other medical man who may be called in your absence. Do not quarrel with the authorities for the sake of an occasional dressing which facilitates their business and costs you a few pence; but if you find any medical man abusing your courtesy, ask him either to take his own dressings or send you the fee.

The author has devised a surgical emergency box (Messrs. Matthews Brothers, Oxford Street, W.), which contains the usual requirements for the police-station.

Conversation with Prisoners.

Inquire of the police whether your patient is a prosecutor or a prisoner, and if the latter, be careful not to put any question of an incriminating character. Rough characters will, however, frequently give you information—name, address, etc.—which they have refused to the police.

Trivial Injuries.

The authorities direct that 'a liberal interpretation' shall be put on regulations applying to the divisional surgeon, and therefore you will frequently be called to trifling injuries. In this connection it must be remembered that an inspector would be unwise to take responsibility where he is not called upon to do so, and that a bloodvessel which is not bleeding in the cold air may do so in a heated cell.

The regulation is that the cells are to be kept at a temperature of not less than 60° and not more than 63°.

POLICE CALLS 3

Injuries not to be touched until your Arrival.

Do not allow the constables to clean up wounds in anticipation of your arrival, because valuable information as to the position of the victim at the time of the infliction of the injury, and of the nature of the instrument used, may be destroyed.

For instance, a prosecutor informs you that 'he was knocked down, and kicked about the head when on the ground.' The appearance of mud, horse-dung, etc., and the direction the stream of blood has taken in the hair, will greatly assist your opinion. The author gave evidence in a case in which the prisoner, charged with biting a policeman's finger, asserted the injuries he himself had sustained were inflicted in the police-station. It was, however, possible to swear that such was not the case, as the *blood was caked about the wounds*, there was mud about them, and the man had not been in the station fifteen minutes before he was surgically treated.

When you have to undress a woman, have the matron present, and if that is not possible, leave the door partly open and stand a constable outside.

If you have to send a woman anywhere on an ambulance, advise that the matron should go with her.

Antiseptics.

Clean your instruments yourself. You cannot do major surgery in a police-station, but you *can*, and you ought to, be antiseptic in what you do.

The Surgeon's Report Book.

The divisional surgeon is required to make an entry in this book as a record of the case and to justify to

Fig. 1.4 (continued)

Force on 30 April 1830. The Metropolitan Police Surgeons Association was formed in 1888 with 156 members. In 1951, the Association was reconstituted as a national body under the leadership of Ralph Summers, so that improvements in the education and training for clinical forensic medicine could be made [28]. The Association of Forensic Physicians (formerly the Association of Police Surgeons) in the UK remained the leading professional body of FPs worldwide, until the formation of a new Faculty of the Royal College of Physicians of London—the Faculty of Forensic and Legal Medicine (FFLM) (www.fflm.ac.uk) in 2005.

The Royal Commission on Criminal Justice in 1993 raised concerns about the lack of quality control of doctors working in the field of clinical forensic medicine [29]. Legislation in England and Wales, the Police and Criminal Evidence Act 1984, resulted in an enhanced role for the doctor [30]. Since the publication of the Royal Commission's report there have been repeated calls for a high quality professional medical service to assist the criminal justice system [31–33].

The FFLM [34] represents forensic physicians, medicolegal and dento-legal advisers (to the medical defense organizations), and medically qualified coroners and a range of other forensic practitioners, e.g. forensic pathologists and psychiatrists. The inaugural meeting was held in April 2006 and objectives confirmed [35]:

- to promote for the public benefit the advancement of education and knowledge in the field of forensic and legal medicine; and
- to develop and maintain for the public benefit the good practice of Forensic and Legal Medicine by ensuring the highest professional standards of competence and ethical integrity.

These objectives may be simplified to ‘Raising standards in forensic and legal medicine: protecting vulnerable people’. For many of its members, those objectives will be best served by a properly regulated specialty of clinical forensic medicine, subject to appropriate clinical governance and standards. In March 2009, the then Home Secretary of the UK Government stated “Guidance as to the level of professional and clinical qualification required for doctors or nurses is issued by the [FFLM]…. Responsibility for recruitment of healthcare professionals is a matter for individual chief police officers, and it is for each police force to make a decision on an individual basis against this guidance…. The FFLM will have an opinion as to what duties should, or should not, be performed by staff at each level in each professional role. There is no mandatory guidance from the police service” (http://www.publications.parliament.uk/pa/cm200809/cmhansrd/cm090318/text/90318w0006.html). The FFLM has published a wide variety of quality standards documents and these are updated regularly. ‘Quality Standards in Forensic Medicine’, which recommended certain standards for those working in general forensic medicine and sexual offence medicine is one example [36].

Global Clinical Forensic Medicine

A number of studies have explored the practice of clinical forensic medicine across the world. Such studies are necessarily snapshots at a given time, as in any jurisdiction police, judicial, criminal and detention systems, and the oversight of those systems, changes. With these changes, come changes in the working practices of such practitioners [37, 38]. These studies have shown the close link between clinical forensic medicine and forensic pathology and how they inter-relate in many different ways. . Adaptations of these studies have been applied both nationally (in Australia) and regionally (across Europe) [39, 40]. The regulation of the clinical aspect of forensic medicine remains much less defined than that of forensic pathology, despite there being many more practitioners in clinical forensic medicine. This lack of internationally regulated standards may result in poor practice and lower standards of practice.

It is essential that doctors working in the field are properly trained [41–43], supervised and work within their scope of practice (see Chap. 2). There are a number of organizations that have been developed to support doctors working in these fields in the UK and Australia [44]. Initial training and continuing professional development are essential to ensure that practitioners have the core competencies to perform the roles required and remain up to date in this rapidly changing area.

A review of complaints against FPs and other HCPs within the UK showed how difficult it is to identify poor performance, simply because the data are not appropriately recorded by the respective healthcare regulators [45]. The nature of complaints made against those working in clinical forensic medicine in the UK is worrying, and the lack of proper oversight, standards and accountability may be responsible [46]. In the previous editions of this book, the following comments (repeated below) have been made about clinical forensic medicine. The italicized comments represent apparent changes that had been noted between the 1997 and 2003 surveys and in the previous edition of this book it was suggested that over a decade ago the 2007/2008 international survey suggested that from 1997–2008 that there were no additional substantial changes (i.e. advances!).

No clear repeatable patterns of clinical forensic medicine practice may be seen on an international basis—*but there appears to be an increase in recognition of the need to have appropriate personnel to undertake the roles required.*

Several countries have informal/ad hoc arrangements to deal with medical and forensic care of detainees and victims—*this still remains the case—often with large centres having physicians specially trained or appointed whilst rural or outlying areas are reliant on non-specialists.*

The emphasis in several countries appears to be on the alleged victim rather than the alleged suspect—*this remains the case although there are suggestions that this approach is being modified*.

The standard of medical care of detainees in police custody is variable—*there appears to be more recognition of the human rights aspects of care of those in police custody*.

There are no international standards of practice or training—*international standards are still lacking—but more countries appear to be developing national standards.*

There are apparent gaps in the investigation of police complaints in some countries—*this remains the case*.

Death in custody statistics are not always in the public domain—*this remains the case—and the investigation of deaths in police custody may still not be independently undertaken.*

In 2019 it would be fair to say that there have now been significant advances in a number of these areas. Perhaps the most important are those where clinical forensic medicine is recognized as an integral and important part of the broad aspects of ‘forensic & legal medicine’. This is now being increasingly recognized as a specialty area of medicine, and when this happens, standards often improve. If such changes are supported by medical regulators or statute, then there are clear drivers for improvement. There now clear recognition of the roles and inter-relationship of FP and forensic pathology and forensic sciences, and indeed in many jurisdictions both clinical and pathological aspects of forensic medicine are undertaken by the same individual.

There is an acceptance in some countries for the use of appropriately trained allied healthcare professionals (e.g. nurses and paramedics) in some settings (notably some aspects of care of detainees in custody) [46]. This development may be influenced by the regional and local nature of specific healthcare problems of detainees and how such targeted healthcare is, or should be delivered [46–51].

There are very few academic centers of forensic medicine in the UK, and many of the posts that do exist are honorary rather than tenured. This situation is similar in many other countries. It is essential that governments and states are lobbied to recognize the societal importance of appropriate clinical forensic medicine with appropriate funding (including academic posts).

In the UK and Europe, after a prolonged period attempting to establish a mono-specialty of Legal Medicine, the European Council of Legal Medicine has established the principle of 'legal and forensic medicine' as a mono-specialty [52]. In the UK the Joint Royal Colleges of Physicians Training Board has established a Specialty Advisory Committee on 'Forensic & Legal Medicine'. There are now a handful of General Medical Council specialists in 'Forensic & Legal Medicine'. These developments are a great stimulus to FPs and to discipline of clinical forensic medicine.

There are many Diplomas and Masters degree courses that are appropriate to FPs [53], and the FFLM has an examination Membership of the Faculty of Forensic & Legal Medicine (MFFLM) which has the same rigor as other Faculties and Colleges such as the Royal College of Physicians [54, 55]. There are also qualifications suitable for nurses and paramedics working in the field.

The Royal College of Pathologists of Australasia established the Faculty of Clinical Forensic Medicine in 2014 (https://www.rcpa.edu.au/Trainees/Faculties/FCFM). They define clinical forensic medicine as that branch of medicine concerned with 'the provision of forensic medical services primarily to the living and the collection and interpretation of information for the purposes of civil and criminal law, the judiciary and the police. It is that branch of clinical medicine that deals with both the medical and legal aspects of patient care.'

The vision of the new Faculty is to pursue excellence in the discipline of Clinical Forensic Medical Services to contribute to the health, wellbeing and safety of the Australasian community. The Faculty's mission is to:

1. Provide professional standards for Australasian doctors who provide Clinical Forensic Medical services;
2. Promote and encourage education, research and training in the field of Clinical Forensic Medicine including ongoing professional development opportunities and maintenance of professional skills schemes;
3. Promote and facilitate greater co-operation between Clinical Forensic Medical practitioners with other participants involved in the legal system, such as the forensic scientists, legal practitioners, justice health providers and law enforcement;
4. Foster a better understanding of Clinical Forensic Medicine, both within the medical profession and among the general public; and
5. Seek and maintain formal recognition of Clinical Forensic Medicine as a specialty.

The RCPA (CFM) faculty is working towards specialist status for physicians in Australasia with appropriate training programs.

Conclusions

There are a number of key areas which must be prioritized in clinical forensic medicine:

1. Recognition that clinical forensic medicine is a distinct area of medicine that requires an appropriate career path, as part of a forensic & legal medicine specialty. This will require training in the same way as any other defined medical specialty.
2. Recognition that high quality clinical forensic medicine is essential to a fair society in order that proper justice may be achieved when medical issues are part of the legal process, and to protect the vulnerable.
3. Recognition that clinical forensic medicine at any level should be monitored and supervised in the same way as any other distinct specialty, such as cardiology or gastroenterology.

Clinical forensic medicine continues to develop, and when effective, supports and enhances judicial systems in the proper, safe and impartial dispensation of justice. Terrorist atrocities, torture and armed conflicts raise issues of human rights at high levels, and these often highlight the work of FPs and other HCPs. FPs and HCPs should ensure that no opportunity is missed to raise the profile of their work and develop appropriate recognition for the often unthanked and complex roles and tasks undertaken.

Key Points

- Both Australia and the UK have established Faculties representing clinical forensic medicine and are working towards specialist status.
- Healthcare professionals, doctors, nurses and paramedics, may provide a wide range of services for the criminal justice system. However they must ensure that they have the appropriate knowledge and skills for their roles and work within their individual scope of practice.

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Fundamental Principles

2

Margaret M. Stark

Learning Objectives

Ability to discuss consent in relation to therapeutic and forensic procedures.

Demonstrate the difference between a professional witness and an expert witness.

Illustrate the importance of documentation and record keeping in relation to clinical notes.

Management of the assessment of capacity and how this may impact on a decision to examine.

Introduction

From the time of Hippocrates, doctors have undertaken to practice medicine in accordance with ethical and professional codes of conduct. In addition, as with any other citizen, they are required to comply with the laws of the country in which they reside and practice and must understand the constraints and obligations these may impose on them. Laws will vary from one jurisdiction to another, although there may be some commonality, for example, secondary legislation deriving from European Union law and the influence of English common law on countries of the old Commonwealth. This chapter is written from the perspective of the law in England and Wales and should be read with that in mind.

Constantly legislation is enacted and amended that is relevant to medical practice. Ignorance of the law is no defense, and today's doctors, and other healthcare professionals (HCPs) (nurses and paramedics) are at risk of prosecution for breaches of the law and professional codes of conduct as no previous generation

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has ever been. With the advent of the internet, patients have become increasingly well informed, have much higher expectations, and are more willing to challenge doctors than their predecessors. Today's doctors are under considerable pressure to keep up to date, not only with advancements in medical practice, but also with changes in the laws governing that practice. It is hoped that this chapter will help to highlight key areas of law with which doctors should be familiar, but this can only be an outline. For advice on individual cases or more detailed legal and ethical guidance, doctors are encouraged to approach their Defense Organizations (e.g. Medical Defence Union (MDU), Medical Protection Society (MPS), and the Medical and Dental Defence Union of Scotland (MDDUS)) in the UK. Similar arrangements operate in other jurisdictions, e.g. Avant in Australia, MPS in South East Asia, The Canadian Medical Protective Association (CMPA), or to refer to guidance from other sources such as the British Medical Association (BMA), the General Medical Council (GMC), the Australian Health Practitioner Regulation Agency (AHPRA) or the Royal College of Australasia Faculty of Clinical Forensic Medicine (RCPA CFM). For those doctors wishing to pursue a career in Forensic and Legal Medicine, the Faculty of Forensic and Legal Medicine (FFLM) of the Royal College of Physicians of London offers a higher professional examination. Membership of the Faculty of Forensic & Legal Medicine (MFFLM) [1] which addresses all the essential areas of law relevant to the practice of forensic medicine.

The GMC state that all doctors must make sure that they have adequate and appropriate insurance or indemnity arrangements in place covering the full scope of their medical practice in the UK [2]. If working for a NHS Trust or Board, or Health and Social Care body in Northern Ireland, the doctor will receive indemnity through a clinical negligence scheme. From April 2019, a new state-backed indemnity scheme will cover clinical negligence claims for all general practitioners and other staff delivering primary care. Doctors are individually responsible for ensuring they hold appropriate professional negligence indemnity for any work they undertake outside their NHS employment.

Doctors should also be aware that individual advice in relation to complaints handling, inquests, disciplinary action (whether by their employer or their regulatory body), and general ethical and professional matters do not fall within the scope of NHS indemnity. All doctors are therefore advised to join an appropriate Defense Organization to ensure they have access to medicolegal advice and representation whether or not their practice is confined to the NHS. The indemnity provided e.g. in an NHS employment, will not provide legal advice or support to the doctor, which may be essential should there be a conflict/tension between the interests/needs of the employer and the needs of the employee.

Increasingly doctors are working with other healthcare professionals (HCPs) in multidisciplinary teams proving clinical forensic medical services to those detained by the police and/or complainants/complainers of assault. Nurses and paramedics working in this field must ensure that they have appropriate indemnity for the role usually provided by their employer.

Scope of Practice

All HCPs must work within the scope of practice as determined by their relevant Regulatory body, e.g. General Medical Council (GMC), Nursing and Midwifery Council (NMC), and Health and Care Professions Council (HCPC).

The GMC in Good Medical Practice states that doctors [2]:

- must be competent in all aspects of your work, including management, research and teaching
- must keep professional knowledge and skills up to date
- must regularly take part in activities that maintain and develop competence and performance
- must recognize and work within the limits of your competence
- consult colleagues where appropriate

The NMC Code [3] states that nurses must recognize and work within the limits of their competence. To achieve this, they must, as appropriate:

- accurately identify, observe and assess signs of normal or worsening physical and mental health in the person receiving care
- make a timely referral to another practitioner when any action, care or treatment is required
- ask for help from a suitably qualified and experienced professional to carry out any action or procedure that is beyond the limits of your competence
- take account of your own personal safety as well as the safety of people in your care
- complete the necessary training before carrying out a new role

The Health and Care Professions Council defines a registrant's scope of practice as: [4]

'*Your scope of practice is the area or areas of your profession in which you have the knowledge, skills and experience to practise lawfully, safely and effectively, in a way that meets our standards and does not pose any danger to the public or yourself. We recognize that a registrant's scope of practice will change over time and that the practice of experienced registrant's often becomes more focused and specialized than that of newly registered colleagues. This might be because of specialization in a certain area or with a particular client group, or a movement into roles in management, education or research*'.

HCPs must introduce themselves to the detainee/police officer/complainant as a doctor, nurse, or paramedic, as appropriate.

Quality Standards now also exist to ensure that there is a competent workforce [5, 6]. The standards stress the need for appropriate recruitment, initial training and induction support, workplace-based supervision, continuing professional development and service level standards. All staff should be working for a higher qualification in the field of forensic and legal medicine [7].

Ethical Principles

Medical Professionalism has been defined as '*a set of values, behaviours and relationships that underpin the trust the public has in doctors*'. [8]

Healthcare professionals who practice as forensic physicians (FPs, forensic medical examiners FMEs, forensic medical officers FMOs, or police surgeons), nurses or paramedics, have a special responsibility towards detainees, who, having been deprived of their liberty, are potentially vulnerable, and unable to protect their own interests. Although human rights legislation is designed to protect those interests, the HCP is in a position to act as an advocate on behalf of a detainee and ensure that their rights are upheld in accordance with the relevant professional and ethical codes of conduct. If a HCP has reason to believe these rights are being ignored or abused, he/she may have a duty to raise these concerns with the appropriate authorities.

In December 2015, the UN General Assembly published revised rules: the United Nations Standard Minimum Rules for the Treatment of Prisoners [9], now known as The Nelson Mandela Rules, setting out what is generally accepted as being good principles and practice in the treatment of prisoners and prison management. These principles should cover those detained in police custody. The European Convention on Human Rights [10] is also of importance, with the following articles of particular relevance to HCPs in the forensic field:

- Article 2 right to life.
- Article 3 right to freedom from torture or inhuman or degrading treatment or punishment.
- Article 5 right to liberty and security.
- Article 6 right to fair trial.
- Article 9 freedom of thought, conscience and religion.

The European Committee for the Prevention of Torture and Inhuman or Degrading Treatment or Punishment (CPT) Standard [11] states that the detainee has '*the right of access to a doctor, including the right to be examined, if the person detained so wishes, by a doctor of his own choice (in addition to any medical examination carried out by a doctor called by the police authorities*).' Other rights are enshrined in the Standard and include the right of the person concerned to have the fact of his detention notified to a third party of his choice (family member, friend, consulate) and the right of access to a lawyer. These are outlined in the Codes of Practice to the Police and Criminal Evidence Act 1984 [12].

The Optional Protocol to the UN Convention Against Torture (OPCAT) [13] is an international human rights treaty designed to strengthen the protection of people deprived of their liberty. The UK ratified OPCAT in December 2003 and was required to establish a National Preventive Mechanism (NPM), set up in 2009, that regularly examines conditions of detention, the treatment of detainees, makes recommendations, and comments on existing or draft legislation with the aim of improving treatment and condition of detention [14]. The UK designated a number of independent bodies already providing independent scrutiny rather than set up a single new NPM. For example in England, these include (among others) the Care Quality Commission, Her Majesty's Inspectorate of Constabulary and Fire and Rescue Services, and the Independent Custody Visiting Association. Not all countries have ratified OPCAT. As of January 2018, the Protocol has 75 signatories and 87 parties; Australia ratified OPCAT in December 2017.

Role of HCP in the Forensic Environment

HCPs working in this environment have two separate roles. In the first instance, they are independent clinical assessors of the complainants/complainers and suspects, and as such, no conventional therapeutic relationship exists. It is important, therefore, that detainees or complainants understand this and the potential ramifications, in order that valid, informed consent can be obtained prior to any examination being conducted. Second, a therapeutic relationship may arise where advice or treatment is offered to a detainee or complainant, but the nature of this relationship will be constrained by the circumstances and the HCP's obligation to pass on relevant information to the police officers responsible for the care and supervision of that individual. This dual accountability has certain parallels with that of occupational health physicians, their employers, and any employees they may be asked to examine or report on. Great care should be exercised when considering issues of consent and confidentiality in such circumstances. For doctors the elements of effective team working are set out by the GMC in *Good Medical Practice* [15] and include the following: effective communication within and outside the team, a respect for the skills and contributions of others, and an awareness of individual roles and responsibilities and lines of accountability. Doctors must take part in systems of quality assurance and quality improvement to promote patient safety, such as audit, responding constructively to the outcomes, taking steps to address any problems and carrying out further training where necessary. It is essential for doctors to regularly reflect on their standards of practice [16].

The GMC states that doctors should be willing to participate in the teaching and training of other doctors and students. As with any other professional duty, doctors who take on a teaching commitment are responsible for ensuring they develop the appropriate skills and competencies for the task. They must also ensure that all staff for whom they are responsible are properly supervised and any appraisal or assessments made are honest and objective.

Most of the ethical principles embodied in codes of professional conduct will be familiar to doctors the world over, although they may vary in the detail from one jurisdiction to another. This is the case in relation to guidance produced by regulatory bodies, medical associations, and boards, whereas other codes, for example the European Convention on Human Rights or declarations produced by the World Medical Association, by definition, transcend these geographical boundaries. Doctors and other HCPs should be familiar with the codes of conduct pertaining to the country in which they practise and should expect to abide by them. A breach of professional ethics may lead to disciplinary action against the HCP and may call into question their registration and hence ability to practice.

The Nursing and Midwifery Council have issued a Code: Professional standards of practice and behavior for nurses, midwives and nursing associates practicing in the UK [3]. The Health and Care Professions Council also produce Standards of conduct, performance, and ethics for their registrants [4] covering the duty of registrants, which includes paramedics.

Consent

It is a long-established principle that an individual of sound mind has the right to determine what will be done with his own body, even if as a consequence of exercising that autonomy his life may be put at risk. This is often referred to as the principle of self-determination and was encapsulated by The House of Lords in its consideration of the seminal case of Airedale NHS Trust v Bland [17]. Lord Keith stated *"It is well established English law that it is unlawful, so as to constitute both a tort (a civil wrong) and the crime of battery, to administer medical treatment to an adult who is conscious and of sound mind without his consent. Such a person is completely at liberty to decline to undergo treatment even if the result of his doing so will be that he will die."*

This principle applies to mentally competent adults, but what of minors or the mentally incompetent adult? How does the law ensure their interests are protected? Case law has established that in these circumstances it is the doctor's duty to act in the best interests of his/her patient. Determining what constitutes a patient's best interests involves a holistic assessment of the individual's needs in the context of his/her circumstances, values, and beliefs. This can be particularly challenging when dealing with patients who have never had the capacity to express their own views. In circumstances in which an individual is temporarily incapacitated, for example, as a result of a road traffic collision, the HCP may do what is necessary in these circumstances to preserve life and prevent deterioration of the patient's condition without the express consent of the individual concerned. They may, however, do no more, and other less pressing decisions relating to medical care must be deferred until the patient has regained capacity to participate in the decision-making process. The Mental Capacity Act 2005 embodies in statute these common law principles and lays down the framework in which mental capacity is assessed. It goes beyond the common law in that it also makes provision to protect the interests of those without others to speak for them, through the appointment of Independent Mental Capacity Advocates (IMCAs).

Requisites for Consent

It has been established above that any intervention without consent may give rise to criminal and/or civil proceedings against the HCP. The minimum requirement in order to protect against a criminal charge is that the patient should understand in broad terms, the nature, purpose, and effect of the proposed treatment. Any failure to provide sufficient information in relation to the risks or benefits of the proposed treatment would render the HCP potentially vulnerable to a civil claim in negligence. For consent to be deemed valid, the HCP should ensure that he is satisfied that the patient is capable of giving consent, has been sufficiently well informed about what is proposed and therefore able to give a true consent, and has then expressly and voluntarily consented to the proposed course of action. The GMC guidance "Consent: patients and doctors making decisions together" [18] sets out in some detail the professional obligations and good practice considerations with which all UK practicing doctors should be familiar and comply.

Capacity

All HCPs must understand the requisites for consent and be capable of determining where this may be in question. In such cases, a formal assessment of capacity should then be conducted as a priority, before any clinical intervention is contemplated. This is a situation the HCP is likely to face on a regular basis. In many cases, the HCP will have the requisite skills to make an assessment of capacity, but in more complex cases it may be necessary to refer the patient for a formal assessment by an independent psychiatrist. In England, this would ideally be a psychiatrist approved under Section 12 of the Mental Health Act 1983 [19]. In a few cases, capacity may still remain in doubt, and in these circumstances, it may be necessary to refer the matter to the courts. The courts will hear such matters as applications for Power of Attorney, for example, where an individual is deemed incapable of managing his or her property and financial affairs.

Understanding Risks and Warnings

There are three separate elements to valid consent, namely, the patient must have capacity, be sufficiently well informed to be capable of understanding that to which he or she is being asked to consent, and give the consent freely and without duress. To satisfy the first of these requirements, the HCP needs to establish that the patient is capable of the following:

1. comprehending and retaining the relevant information.
2. believes that information.
3. can weigh up the information in the balance and arrive at a choice [20].

From this it is clear that valid consent requires more than a signature on a form, and that the latter is of itself, insufficient evidence to mount a successful defense against a civil claim in negligence alleging lack of consent based on a failure to warn adequately. Such claims alleging that risks were not explained or adequate warnings given are arising more and more frequently in medical litigation. It is therefore essential for those seeking consent to spend adequate time explaining the nature and purpose of the proposed investigation or treatment and discussing any risks or adverse outcomes, as well as alternative treatment options available. The standard consent forms produced by the Department of Health provide a useful prompt to those completing them to help ensure that all these issues are considered. The patient's questions about the proposed intervention should be answered frankly and truthfully as was made clear by the courts in the case of Sidaway [21]. The discussions should be undertaken by those with the appropriate knowledge and experience to deal with them, and ideally, the individual who will be performing the procedure.

English law has been slow to follow other common law jurisdictions (e.g. Canada, Australia, and the United States) regarding the nature of the information that must be imparted for consent to be deemed valid. The law has shifted from a paternalistic approach, applying the "reasonable doctor" test based on the Bolam [22] principle of what a reasonable doctor in the circumstances would have told the patient, to a much more patient-focused approach, applying the "prudent patient" test, i.e., what a reasonable patient in those circumstances would want to know. For example, in the leading Australian case [23], the courts imposed a duty to warn of remote (1 in 14,000) but serious complications of elective eye surgery, even though professional opinion in Australia at the time gave evidence that they would not have warned of so remote a risk.

In the United States and Canada, the law about the duty to warn of risks has long been much more stringent. Many US courts recognize a duty on a doctor to warn a patient of the risks inherent in a proposed treatment. In the leading case [24], the District of Columbia appeals court imposed an objective "prudent patient" test and enunciated the following four principles:

1. Every human being of adult years and sound mind has a right to determine what shall happen to his or her body (the principle of self-determination).
2. Consent is the informed exercise of choice and that entails an opportunity to evaluate knowledgeably the options available and their attendant risks.
3. The doctor must therefore disclose all "material risks."
4. The doctor must retain "therapeutic privilege."

A "material risk" was held to be one that a reasonable person, in what the doctor knows, or should know to be the patient's position, would likely attach significance to in deciding whether to forego the proposed treatment- this test is what is known as the "prudent patient test." However, the court held that a doctor must retain therapeutic privilege by which he or she is entitled to withhold from the patient information about risk, which, if disclosed, would pose a serious threat of psychological harm to the patient. In the leading Canadian case [25], broad agreement was expressed with these propositions.

Until recently, English law continued to allow doctors' discretion in deciding what information should be imparted to the particular patient being advised. The cases of Sidaway and Bolitho [26] set the constraints under which this discretion was exercised, namely that the doctors must be supported by a body of medical opinion that is not only responsible, but also stands up to logical and scientific analysis and scrutiny as applied by the courts. In English law, the pendulum has now swung fully in the direction of the "prudent patient," in line with other common law jurisdictions. Furthermore, in Chester v Afshar [27], the House of Lords effectively removed the requirement to prove a causal link between an alleged breach of duty (in this case, a failure to warn of a material risk) and the injury sustained. In March 2015, a unanimous decision in the United Kingdom Supreme Court (Montgomery v Lanarkshire Health Board [28]) made it clear that doctors must ensure their patients are aware of the risks of any treatments they offer and of the availability of any reasonable alternatives. This means that doctors can no longer rely on the support of a responsible body of medical opinion - the Bolam test - in deciding what information they should give to patients.

Hence, if a practitioner fails to warn of such a risk, and that risk eventuates, the practitioner is liable, regardless of whether or not the treatment is carried out negligently.

Patients' rights to self-determination and personal autonomy based on full disclosure of relevant information is the legal requirement for consent.

Voluntary Agreement

Consent given under duress, or where the patient's free choice may be influenced by others or by the circumstances in which the consent is obtained, is not valid. The HCP must be satisfied that a patient's consent is given of his own volition and as an expression of his personal autonomy to exercise his free choice about whether or not to undergo the proposed investigation, procedure, or treatment.

Consent may be implicit or explicit, verbal or written, the validity of each depending upon the circumstances and what is being proposed. Implied consent may be sufficient for some purposes, but not others: for example, a patient holding out her arm in response to a doctor's request to take a blood sample, or measure blood pressure. Where a more complex intervention is proposed, express consent will usually be necessary: for example, consent to undergo surgery. Express consent can be verbal or written. Again, a decision as to what is appropriate will depend upon the circumstances. Although verbal consent is legitimate, the advantage of written consent is evidential. Disputes may arise in the future about the nature and extent of the consent obtained, information given in relation to warnings of side effects or risks, and alternative treatment options. In the absence of a contemporaneous note, the courts will need to decide whose version of events is to be believed, often preferring the patient's recall of a significant life event over and above that of the HCP's recollection of a discussion that took place with one patient among many. Ideally, consent should be taken by the doctor who will be performing the procedure, but at the very least, must be someone with the appropriate level of knowledge and skills to be able to respond appropriately and knowledgeably to any questions the patient may have about what is proposed.

The contemporaneous note should record details of the nature, purpose, and effect of what is proposed, together with information about the relative risks and benefits of treatment, likely success rate and alternative treatment options. For more complex interventions, it may be helpful to supplement these discussions with a printed information booklet or other resource, for example, a CD-ROM which the patient can take away and consider at leisure. Patients should be given time to reflect and discuss what they have been told with loved ones, should they wish to do so. This should be followed up with a further opportunity for the patient to ask questions before finally committing to the procedure.

Particular care should be taken when consent is being obtained in circumstances where the procedure has a forensic rather than a therapeutic purpose, and the HCP is not the patient's usual medical attendant, but may be carrying out tasks that may have a wider implication for the patient, for example, impacting on the liberty of that individual (as a HCP working in custody), or on his future financial security (in making an assessment for the purposes of a civil claim).

Adult Patients Who Lack Capacity

The Mental Capacity Act 2005, which came into effect in 2007 in England and Wales, gave statutory effect to previous common law principles and govern the decision making in relation to adults who lack capacity to consent.

The principles of the MCA 2005 include:

1. a person must be assumed to have capacity unless it is established that he lacks capacity
2. a person is not to be treated as unable to make a decision unless all practical steps to help do so have been taken without success
3. a person is not to be treated as unable to make a decision merely because he makes an unwise decision
4. an act done or decision made under this Act for on behalf of a person who lacks capacity must be done or made in his best interests
5. before the act is done or the decision is made regard must be had to whether the purpose for which it is needed can be as effectively achieved in a way that is less restrictive of the person's rights and freedom of action

Where capacity is temporarily impaired due to, for example, intoxication with alcohol and/or drugs, then decisions and procedures should wait till the patient can make the required decision. In an emergency anything done must be in the patient's best interests. If it is expected that the lack of capacity may persist a forensic medical examination may be performed in certain circumstances [29, 30], and consideration should be given to the following:

- Therapeutic care always takes priority
- Inform the consultant who is responsible for the medical care of the patient of the nature and purpose of the proposed examination to ensure that they have no objections to it being undertaken

- Speak with relatives/significant others about what is involved in the examination
- Consider taking advice from a senior clinician
- Consider taking advice from your medical defense organization
- Consider discussing with the hospital lawyers/lead for safeguarding/mental capacity lead
- Document all the steps taken in the decision that the patient lacks capacity and that an examination is their best interests
- The patient should be informed of what was done/not done and why (when appropriate).

Minors and Consent

In 1969, the Family Law Reform Act gave minors who had reached the age of 16 years or over the statutory right to consent to treatment without the requirement for the consent of a parent or guardian. The legal position relating to minors less than 16 years was established in the case of Gillick [31]. The House of Lords decided that valid consent could be given by minors under 16 years, provided they understood the issues involved. The particular case in question concerned the provision of contraceptive advice to girls less than 16 years in circumstances in which a parent objected. The House of Lords held that parental rights to determine whether a child under 16 years old received treatment terminated if and when the child achieved a sufficient understanding and intelligence to be able to comprehend the issues involved. The determinant factor is therefore the capacity to understand, rather than the age or status of the individual concerned.

The right of a minor to refuse treatment is much more complex. In order for treatment of a minor under the age of 18 years to be lawful, the consent is required of either the child concerned (if competent) or anyone with parental responsibility (including the courts). When a minor refuses treatment, it may still be lawful to proceed if the doctor has the requisite consent from any other person with authority to give it. Clearly there are practical as well as ethical issues in relation to compelling a minor to undergo treatment against their wishes. The doctor will need to make a judgment as to the relative seriousness of the issue in question and the potential consequences of proceeding or not proceeding with the treatment. In complex cases or where there is disagreement about what is the preferred course of action, it may be necessary to make an application to the courts to resolve this. Case law has shown that, in general, the courts are reluctant to allow a minor to refuse a course of treatment, in consequence of which, his life may be put at serious risk, preferring to err on the side of preserving life, at least until the child in question has attained adulthood at which point he may exercise his right to autonomy to refuse treatment.

In the custody environment the FFLM [32] has produced advice for HCPs in respect of forensic examinations. The rules with regard to obtaining intimate samples (see below) from a detained person require ‘appropriate consent’ in order for the intimate sample evidence to be admissible. ‘Appropriate consent’ with regard to children and young people is defined in section 65 of the Police and Criminal Evidence Act (PACE), 1984, as meaning:

1. in relation to a person between their 14th and 18th birthday, the consent of that person and his parent or guardian; and.
2. in relation to a person who has not attained the age of 14 years, the consent of his parent or guardian.

Persons with parental responsibility include (this will vary between jurisdictions):

- Mother
  - automatically has parental responsibility (unless removed by a court)
- Father
  - acquires responsibility if he is married to the mother at the time of the child's birth or anytime thereafter
  - unmarried father if he is recorded on the birth certificate of the child from first December 2003 in England and Wales or from 14th May 2006 in Scotland
  - may still have parental responsibility by way of a court registered parental responsibility agreement even if birth registered before above dates
- Parental responsibility can be obtained by others with agreement or by court order (e.g. step-parents/adoptive parents)

Where the consent of a parent or guardian is required for these procedures, it is not necessary for the parent or guardian to be at the police station to give that consent. However, where the consent of the child or young person is required it must be obtained in the presence of an appropriate adult, who may be the parent or guardian or some other suitable person over the age of 18 years.

If a young person is arrested under the Road Traffic Act (RTA) and samples are required it is not necessary to seek consent from a parent or guardian as long as the young person consents. Both the police officer and the HCP need to be to be independently satisfied that the young person has consented to providing a blood sample. If the young person has the capacity to consent but refuses to do so in respect of providing a blood specimen then (subject to the statutory defense of reasonable excuse) they commit the offence contrary to section 7(6) (RTA).

The Professional Duty of Candour [33]

Every healthcare professional must be open and honest with patients when something that goes wrong with their treatment or care causes, or has the potential to cause, harm or distress. This means that healthcare professionals must:

- tell the patient (or, where appropriate, the patient's advocate, carer or family) when something has gone wrong

- apologise to the patient (or, where appropriate, the patient's advocate, carer or family)
- offer an appropriate remedy or support to put matters right (if possible)
- explain fully to the patient (or, where appropriate, the patient's advocate, carer or family) the short and long term effects of what has happened.

Healthcare professionals must also be open and honest with their colleagues, employers and relevant organisations, and take part in reviews and investigations when requested. They must also be open and honest with their regulators, raising concerns where appropriate. They must support and encourage each other to be open and honest, and not stop someone from raising concerns. A doctor must inform the GMC if, anywhere in the world:

1. they have accepted a caution from the police or been criticized by an official inquiry
2. they have been charged with or found guilty of a criminal offence
3. another professional body has made a finding against your registration as a result of fitness to practise procedures [34].

Whistleblowing

Whistleblowing refers to the act of a worker raising a concern about serious issues in the workplace, which may include malpractice or other serious health and safety concerns, which is done in the public interest [35]. The legal framework is set out in the Employment Rights Act 1996 (as amended by the Public Interest Disclosure Act 1998). The Act protects workers that disclose information about malpractice at their workplace, or former workplace, provided certain conditions in relation to the nature of the information disclosed and the person to whom it is disclosed, are met. The GMC is a Prescribed Person under the Public Interest Disclosure (Prescribed Persons) Order 2014 so those who make a whistleblowing disclosure to the GMC which is relevant to their statutory functions will receive legal protection provided they hold a reasonable belief that the information disclosed is true [36].

Illustrative case *A 15 year old boy is under arrest for murder and the police request intimate samples to be taken by the HCP. On discussion with the boy it is clear he is aware of proceedings, is Gillick competent, and consents to have the samples taken. Appropriate consent for the samples means that the HCP should speak to the person with parental responsibility. The mother of boy is contactable by telephone and the HCP discusses the situation with her. She has a serious mental illness but appears to understand the request for forensic samples, and provides her consent. An appropriate adult is called in view of the suspect being under 18 years of age. You ensure that you document all the steps in your decision-making.*

Intimate Samples and Intimate Searches

Section 62 of the Police and Criminal Evidence Act (PACE) 1984 provides that intimate samples can only be taken from an individual if authorized by a police inspector (or superintendent in the case of those detained under terrorism legislation) and if the requisite consent is obtained (see Chap. 3).

Section 55 of PACE provides that an intimate search of an individual may be conducted on the authority of a police officer of at least the rank of inspector only if there are grounds for suspecting that an individual is hiding an object that might be used to cause physical injury to himself or others and might do so while in detention or a class A controlled drug and was in possession of it with the appropriate criminal intent before his arrest.

A doctor or nurse called upon to conduct an intimate search will be wise to consider carefully whether a detainee is likely to be able to give a free and voluntary consent in such circumstances; an intimate search should not be conducted unless the doctor or nurse is thoroughly satisfied that the individual has given valid consent. An intimate search may, exceptionally, be conducted by a doctor or nurse if he believes it is necessary to remove a concealed object that is an immediate danger to the life or personal safety of those responsible for the detainee's supervision. It is essential that the doctor or nurse attends to discuss with the detainee the pros and cons of having drugs concealed.

The doctor or nurse will be guided by the authorities as to which orifice(s) to search. It is essential that the doctor or nurse has the appropriate knowledge and skills and is competent to perform the required clinical examination of the various orifices that may be used to conceal drugs/weapons [37].

Ideally, a chaperone should also be present in addition to the police officer.

The BMA and FFLM consider that such searches should be carried out by a healthcare professional only when the individual has given consent [38]. If consent is not given, the doctor or nurse should refuse to participate and have no further involvement in the search. In certain circumstances in relation to the concealment of Class A drugs the police may request x-rays and ultrasound scans to be taken of a detainee by a doctor or nurse in suitable medical premises. Once again, the detainee should give appropriate consent [39].

Video and Audio Recordings

The GMC [40] and BMA [41] have issued guidance requiring doctors to inform patients before making a video or audio recording and, except in situations in which consent may be understood by the patient's cooperation with a procedure (e.g. radiographic investigation), to obtain his or her explicit consent. Doctors may make recordings without consent in exceptional circumstances, such as when it is believed a child has been the victim of abuse.

If a recording has been made in the course of investigation or treatment of a patient, but the doctor now wishes to use it for another purpose, for example as a teaching or training aid, or in research, the patient's consent must be obtained. Recordings may not be published or broadcast in any form without the explicit, written consent of the patient. Consent is required before recordings are published in textbooks or journals or before they enter the public domain. Consent is required whether or not the patient can be identified from the recording. Where a patient lacks capacity to make a decision, the relevant legislation must be considered. The doctor should be satisfied that making recordings of the patient for secondary purposes is necessary, and benefits the patient or is in their best interests and that the purpose cannot be achieved in a way that is less restrictive of the patient's rights and choices [40].

Specific care has to be taken with the recording, storage, and use of intimate images where the FFLM has produced joint guidance with RCPCH on the procedure to be followed in this respect [42].

Recording Telephone Calls

Many countries have laws or regulations that govern the electronic recording of telephone conversations, which are designed to protect individuals' rights [43]. Commonly, a provision will include stating that persons whose telephone calls are being recorded must be informed of that fact—the details of the provision varying from country to country.

A recording may be an invaluable aid for forensic evidence, or to help refute a complaint, or a claim for compensation, but practitioners who make electronic recordings of telephone calls must be familiar with, and comply with, local laws and codes of practice.

Emergencies

In a medical emergency in which a patient is unable to give or withhold consent as a result of their medical condition at the time (e.g. unconscious patients), and there is no known clear written instruction to the contrary in terms of a valid, extant advance directive made by the patient, treatment that is clearly essential to save life or to prevent serious harm may and indeed should be given. However, non-urgent treatment should be deferred until the patient is able to give consent. Patients with longstanding mental incapacity should be given treatment deemed to be in their best interests. Again, in an emergency situation, this should be limited to immediately necessary treatment and nonurgent interventions postponed until a more comprehensive assessment of the patient's best interests can be undertaken.

Confidentiality

> *And whatsoever I shall see or hear in the course of my profession, as well as outside my profession in my intercourse with men, if it be what should not be published abroad, I will never divulge, holding such things to be holy secrets…* [44].

> *There continues to be a real concern across all sectors, but particularly in the health services, about the risk of breaching confidentiality or data protection law by sharing concerns about a child's safety.*
>
> *Whilst the law rightly seeks to preserve individuals' privacy and confidentiality, it should not be used (and was never intended) as a barrier to appropriate information sharing between professionals. The safety and welfare of children is of paramount importance* [45].

Information acquired by a medical practitioner and other HCPs from, or about, a patient in the course of their professional work is confidential and should not be released to any third party without the consent of the patient or without proper justification in accordance with professional guidance. This duty of confidence to a patient continues even after the patient's death.

The GMC has issued a comprehensive set of guidance documents [46] which set out the professional obligations of a doctor with reference to the statutory framework and gives examples of how and in what specific circumstances breaching a patient's confidence may be justified.

Doctors are responsible for the safekeeping of confidential information obtained in a professional capacity. Information thus obtained from a patient should not generally be disclosed to others without the patient's consent, except in certain specific circumstances. These include where there is a legal duty to do so or where there is an overriding public interest in disclosure, for example, where a failure to disclose the information could put others at serious risk. Most patients would expect information about them to be shared with other healthcare professionals involved in their care, and consent in these circumstances may be implied. Patients may not, however, be aware that information may be shared for other purposes, for example, service planning and financial audit. As a registered medical practitioner, you must be satisfied that patients have access to information about how their details may be used and their right to object. If patient identifiable data are to be disclosed, express consent should be sought and a patient's right to withhold consent should be respected unless disclosure without consent can be justified.

As a general rule, when making a disclosure of confidential information to a third party, only the minimum information necessary to achieve the objective should be disclosed. The doctor should be satisfied that the person(s) to whom the disclosure is made understands and respects that confidentiality. The NMC provides similar guidance [47]:

"…*share necessary information with other healthcare professionals and agencies only when the interests of patient safety and public protection override the need for confidentiality*…".

Death and Confidentiality

The doctor's duty of confidentiality extends beyond the death of the patient. The extent to which information can properly be disclosed after death depends on the circumstances. The GMC (section 135) [46] has provided the following guidance where relevant information about a patient who has died must be disclosed:

- when disclosure is required by law
- to help a coroner, procurator fiscal or other similar officer with an inquest or fatal accident inquiry
- on death certificates, which you must complete honestly and fully
- when a person has a right of access to records under the *Access to Health Records Act 1990* or the *Access to Health Records (Northern Ireland) Order 1993*, unless an exemption applies
- when disclosure is necessary to meet a statutory duty of candour.

If in doubt about the appropriateness of making a disclosure relating to a deceased patient, the doctor should contact his defense organization for further advice. If the doctor is aware of any information held about the deceased that the deceased had previously expressly indicated should not be shared after his death, then these wishes should be respected. Information may also be withheld, if in the opinion of the holder of the record, disclosure would cause serious harm to the mental or physical welfare of another person.

The BMA's guidance [48] recommend that HCPs *should counsel their patients about the possibility of disclosure after death and solicit views about disclosure where it is obvious that there may be some sensitivity. Such discussions should be recorded in the records*.

Detention and Confidentiality

The HCP should exercise particular care over confidentiality when examining persons who are detained in custody. When taking a medical history and examining a detainee, it is common for a police officer or other detaining official to be in attendance, sometimes in the role of a "chaperone," or possibly simply posted nearby where they can overhear the conversation. Such officials will not owe the detainee a duty of confidence in the same way a HCP does, nor will they be subject to professional sanctions for breaching that confidence.

In considering the presence of a chaperone the CPT Standards state [11]:

'All medical examinations of persons in police custody must be conducted out of the hearing of law enforcement officials and, unless the doctor concerned requests otherwise in a particular case, out of the sight of such officials.'

Although the standard cites doctors only, it is also the expected standard for all healthcare professionals working in the custody environment. The GMC [49] recommends the use of a chaperone when undertaking intimate examinations and this applies whether or not the doctor is the same gender as the patient, ideally the chaperone should be another trained HCP. Where the doctor's own safety is at risk the chaperone/observer should be trained in control and restraint. In such cases, the presence of custodial staff in close proximity to the patient/detainee may be unavoidable. Certain legal procedures, e.g. an intimate search of a juvenile or vulnerable person, require the presence of a same sex appropriate adult (Annex A) [12].

The HCP called upon to examine a detainee must take great care to ensure that the person being examined understands the role of the HCP and the implications for confidentiality. The detainee must understand and agree to the terms of the consultation before any medical information is obtained, preferably by giving written consent.

In the rest of this chapter, only the central issues can be highlighted; local rules and circumstances dictate how these may be resolved in individual circumstances.

Exceptions to the General Duty of Confidentiality

Under certain circumstances, a doctor may disclose confidential information obtained about a patient. For a full consideration of these, please refer to the latest GMC guidance [46] or equivalent locally relevant guidance.

With the Patient's Consent

The patient may agree to confidential information about him being shared with others in a number of situations. The most usual of these is where information is shared with other HCPs involved in the care and treatment of the patient. Consent to disclosure in these circumstances may be implied. All doctors in clinical practice have a duty to participate in local clinical audit and in National Confidential Inquiries. Patients should be made aware that their information may be used in this way and that they have the right to object. A patient may also consent to the release of information for employment or insurance purposes, housing and welfare benefits, and references and legal proceedings. In these circumstances, care should be taken to ensure that the patient is aware of the nature and extent of the proposed disclosure and to whom the disclosure will be made and agrees to it. Information may not normally be released to these parties without the patient express consent.

Illustrative case *The police contact you to request the 'body diagrams' from an assessment you performed one month ago. At that time the police asked you to see the detainee to document the injuries he sustained in the incident leading to his arrest. On review of your notes you realise that the detainee did not sign the consent form for the release of records. Therefore you ask the police to obtain up-to-date consent from the detainee for the release of the body diagrams which are part of the medical records. You advise that on receipt of the consent to release you would prepare a professional witness statement which would provide a clear account of your assessment and the interpretation of the injuries.*

Disclosures Required by Law

The doctor must disclose information about a patient where this is specifically required by law. Registered doctors in the UK have a statutory duty to notify suspected cases of certain infectious diseases. A doctor who performs a termination of pregnancy must notify the appropriate chief medical officer within 7 days of the termination. In relation to the management of controlled drugs there are regulations where responsible bodies are required to cooperate with each other in relation to the handling of and acting on shared information in relation to the management and use of controlled drugs. As a matter of good practice, wherever practicable, you should inform patients of your obligations and advise them what information will be disclosed and to whom, unless this would undermine the purpose of the disclosure.

There are a number of statutory bodies that have powers to access patients' records as part of their duty to investigate complaints, criminal activities (e.g. fraud), or healthcare professionals' fitness to practice. You should comply with such requests provided you are satisfied that the disclosure is required by law or that it can otherwise be justified. You may wish to ask the relevant body to provide you with details of the statutory requirement on which they are relying and seek advice from your defense organization if in doubt. Most such statutory bodies will have Codes of Practice which set out how they will access and use personal information. You need to be clear that where information is requested but not required by law, you should seek the patient's consent before disclosure unless you consider the disclosure can be justified in the public interest.

Disclosure of confidential information during the course of judicial proceedings should only be made either with the express consent of the patient, or if the presiding judge directs the doctor to do so. If you are called to give evidence in court and you do not have the patient's consent to release information about them, you should explain this to the judge or presiding officer of the court. The judge will then decide whether the interests of justice in making the disclosure outweigh the patient's interests in keeping the information confidential. You must comply with a direction from a judge to disclose confidential information. Failure to do so may otherwise put you at risk of being held in contempt of court, the penalties for which may include a fine and/or a custodial sentence. Requests for information from the police or solicitors acting on behalf of the patient or a third party normally require the patient's consent, unless the disclosure can be justified in the public interest (see below).

Statutory Restrictions on Disclosing Information about Patients

The GMC [46] outline a number of statutory restrictions on disclosing information about patients:

Gender Recognition Act 2004 (UK)

Section 22 of the Act makes it an offence to disclose 'protected information' when that information is acquired in an official capacity. 'Protected information' is defined as information about a person's application for gender recognition and a person's gender history after that person has changed gender under the Act.

Human Fertilisation and Embryology Act 1990 (UK)

Section 33A protects the confidentiality of information kept by clinics and the Human Fertilisation and Embryology Authority. Information may be accessed or disclosed only in the specific circumstances set out in the Act. Disclosing information that identifies the patient in other circumstances without the patient's prior consent is a criminal offence.

The National Health Service (Venereal Diseases) Regulations 1974 (Wales) and the NHS Trusts and Primary Care Trusts (Sexually Transmitted Diseases) Directions 2000 (England)

These regulations provide that any information capable of identifying an individual who is examined or treated for any sexually transmitted disease, including HIV, shall not be disclosed, other than to a medical practitioner in connection with the treatment of the individual in relation to that disease or for the prevention of the spread of the disease.

Medical Teaching, Research, and Audit

As a general rule, where possible, patient data used for teaching, audit, or research purposes should be anonymized and express consent should be obtained before identifiable patient data are used in this way. For the purposes of local clinical audit, it is sufficient that patients are made aware their data may be used in this way and of their right to object. Disclosure of personal information without consent is permitted or has been approved under section 251 of the *National Health Service Act 2006* (which applies in England and Wales) or the *Health and Social Care (Control of Data Processing) Act (Northern Ireland) 2016*. These pieces of law allow the common law duty of confidentiality to be set aside for defined purposes where it is not possible to use anonymized information and where seeking consent is not practicable.

Disclosures in the Public Interest

As with all disclosures made without consent of the patient, the doctor should consider whether the proposed disclosure is necessary for the intended purpose and whether this could be achieved if the information were to be disclosed in anonymized or coded form. Disclosure of identifiable patient information may be justified where a failure to do so could put individuals other than the patient at risk of death or serious harm. Examples would include a disclosure to the DVLA about a patient who continues to drive against medical advice, or who places others at risk by failing to disclose a serious communicable disease. Each case must be judged on its individual merits, and if in doubt, doctors should seek specialist advice from their defense organization.

Another circumstance in which a disclosure without consent may be justified is to assist the police in the investigation, prevention, or prosecution of a serious crime. There is no agreed definition of what constitutes "serious crime," although it is generally accepted that these usually refer to crimes against the person (such as murder, rape, assault) and serious harm to the state or to public order. Crimes against property (with the exception of arson where there may be a risk to life) and financial crimes, unless substantial, are not usually considered to fall into this category. Doctors should also consider the circumstances in which the request is being made. For example, a doctor may be persuaded to release information to assist the police in apprehending a murder suspect who is still at large, and hence, where there is still a risk to the public, but not to release information about a suspect who is already in custody without either the patient's consent or an order from the court.

A patient who is violent or dangerous poses particular dilemmas for the doctor. In the course of a consultation, a patient may tell a doctor that he or she intends to perpetrate some serious harm on another person. Each case must be assessed on its own facts; however, under some circumstances, the doctor may be sufficiently concerned for the welfare of the third party to disclose information to the intended victim or to the police or other person in authority with the power to take appropriate action. Indeed a failure to act in such circumstances could lead to criticism by the court, as happened in the case of Tarasoff [50] in California, in which a specialist psychologist failed to warn the girlfriend of a patient who threatened to kill her, and subsequently carried out the threat. The court determined that while there was no general duty to protect or warn third parties, a special relationship may impose such a duty. In the United Kingdom, a psychiatrist was sued by a patient with a history of violence, for releasing a report about him, prepared at the request of his solicitors in connection with an application for release from detention, without his consent [51]. The psychiatrist advised against release and the patient's solicitors therefore decided not to use the report. The doctor, however, was so concerned about his findings that he released a copy of the report to the relevant authorities, as a consequence of which, the patient's application for release was refused. The patient subsequently filed a civil claim for compensation but this failed, the court holding that the psychiatrist was entitled, under the circumstances, to put his duty to the public above the patient's right to confidentiality.

The GMC provides an annex outlining the key legislation in relation to confidentiality [52]. Under the Terrorism Act 2000 (s.38B) it is a criminal offence for a person to fail to disclose information to the police that they know, or believe might be relevant, in preventing an act of terrorism or securing the arrest, prosecution or conviction of a person for a terrorist act. In relation to traffic offences all citizens must give the police on request any information which they have that may identify a driver alleged to have committed a traffic offence (Road Traffic Act 1988). The Crime and Disorder Act of 1998 (s.115) permits disclosure to organizations such as the police local authorities and probation services but this is not a legal obligation. Information should be disclosed if the patient consents or there is an overriding public interest or in response to a court order. Section 26 of the Counter-Terrorism and Security Act 2015 requires those working in health authorities to have 'due regard to the need to prevent people from being drawn into terrorism', the Prevent duty. All HCPs should have level 3 child safeguarding and adult safeguarding training which should cover this duty.

Duty to Report Gunshot and Knife Wounds

The GMC provide guidance to doctors in relation to reporting gunshot and knife wounds [53]. The police should be informed whenever a patient presents with a gunshot wound or a wound that may have been inflicted by a knife or other sharp instrument, other than self-inflicted wounds or those sustained by accident. Personal information should not be disclosed to the police at the initial stage. On the attendance of the police, as long as the patient's clinical condition permits, consent should be sought from the patient to speak to the police. The consequences of a refusal of consent should be clearly explained to the patient, but the patient's decision should nevertheless be respected. Any subsequent decision to disclose information without consent must be justified by the doctor in the usual way, for example, to assist the police in the investigation of a serious crime. The information disclosed should be the minimum necessary to achieve the objective of the disclosure. If there is any doubt about whether disclosure without consent is justified, the decision should be made by, or with the agreement of, the consultant in charge or the healthcare organization's Caldicott or data guardian. If a child, under 18 years of age, attends for treatment for a gunshot wound or a wound from an attack with a knife, blade or other sharp instrument then there would be concerns regarding child safeguarding and appropriate steps should be taken [54].

Disclosures to Protect the Patient

If a doctor considers disclosure of confidential information is necessary for the protection of the patient, he should explain his reasons for this and encourage the patient to consent to the disclosure. However, a doctor should normally abide by a competent patient's refusal to consent, even if the disclosure leaves him or her, but no one else, at risk of serious harm. Disclosure may be justified if it is not practicable to seek consent, for example, where doing so would prejudice the purpose of the disclosure.

HCPs working in the police custodial environment, or within a sexual assault referral center, may come across vulnerable adults and children who need to be referred for safeguarding. For example child sexual exploitation (CSE) is a type of child abuse where a young person is encouraged, or forced, to take part in sexual activity in exchange for something. Cases of forced marriage where one or both people do not consent to the marriage and pressure or abuse is used. This is a form of domestic/child abuse and a serious abuse of human rights. There is a mandatory duty to report Female Genital Mutilation IN the UK if it appears to have been carried out on a girl under the age of 18 (Female Genital Mutilation Act 2003 [55].

Disclosures to Protect Others

Disclosure of identifiable confidential patient information may be justified without consent if in the doctor's judgement, a failure to make the disclosure could put others at risk of serious harm. In these cases, the doctor must weigh the patient's interest in keeping the information confidential against the public interest, or the interests of another individual, in releasing it. This is dealt with more fully in the section on Public Interest disclosures above.

Disclosures About Patients Who Lack the Capacity to Consent

Where a patient is incapable of consenting to disclosure of information about him, either because of a disorder or arrested development of the mind, or because of temporary incapacity for example, unconscious patients, or because the patient is a minor and lacks the maturity to reach a decision, a doctor must either obtain consent from someone with the authority to act on the patient's behalf, or if this is not possible, do what he considers necessary and in the best interests of his patient. In relation to safeguarding adults the Care Act 2014 (England) requires 'relevant partners' to cooperate with local authorities making enquiries about adults at risk unless to do so would be incompatible with their own duties, or would otherwise have an adverse effect on the exercise of its functions [52].

For a fuller discussion of those with authority to consent on behalf of minors and incapacitated adults, see the section on consent above. In making an assessment of best interests, the doctor should take into consideration the views of relatives and carers and any previously known wishes of the patient including the existence of a valid advance directive.

Where there are potential child protection/safeguarding concerns, doctors should be aware of their statutory duties under relevant legislation including, for example, the Children Act 1989 and 2004, to make the best interests of the child their paramount consideration and to share relevant information with other agencies. In situations involving vulnerable adults, for example where the doctor is concerned the patient may be the victim of neglect or abuse, and the doctor believes the disclosure is in the patient's best interests and or is necessary to protect others from risk of serious harm, he should pass relevant information promptly to an appropriate authority.

Record Keeping

All HCPs should keep objective, factual records of their consultations with patients and of other professional work where the information recorded should be relevant to the purpose for which the note was made. Not only is this desirable per se, but it is a professional requirement. Current GMC guidance [2] states that, in providing care, doctors should keep clear, accurate, and legible records, reporting the relevant clinical findings, the decisions made, the information given to patients, and any drugs prescribed or other investigation or treatment. Further, the records should be made at the same time as the events being recorded or as soon as possible thereafter. These standards apply to both paper and electronic records. Where retrospective entries need to be added to the record, these should be clearly recorded as such and dated and timed accordingly. Audit trails allow the exact time an amendment is made in electronic records to be identified and a failure to flag an entry as retrospective could call into question the motivation of the maker of the record.

When handling patient identifiable information there are a number of fundamental principles known as the Caldicott principles to bear in mind.

The Caldicott Principles (2013) Are as follows [56]

Principle 1 - Justify the Purpose(s) for Using Confidential Information

Every proposed use or transfer of personal confidential data within or from an organisation should be clearly defined, scrutinised and documented, with continuing uses regularly reviewed, by an appropriate guardian.

Principle 2 - Don't Use Personal Confidential Data unless it Is Absolutely Necessary

Personal confidential data items should not be included unless it is essential for the specified purpose(s) of that flow. The need for patients to be identified should be considered at each stage of satisfying the purpose(s).

Principle 3 - Use the Minimum Necessary Personal Confidential Data

Where use of personal confidential data is considered to be essential, the inclusion of each individual item of data should be considered and justified so that the minimum amount of personal confidential data is transferred or accessible as is necessary for a given function to be carried out.

Principle 4 - Access to Personal Confidential Data Should Be on a Strict Need-to-Know Basis

Only those individuals who need access to personal confidential data should have access to it, and they should only have access to the data items that they need to see. This may mean introducing access controls or splitting data flows where one data flow is used for several purposes.

Principle 5 - Everyone with Access to Personal Confidential Data Should Be Aware of their Responsibilities

Action should be taken to ensure that those handling personal confidential data - both clinical and non-clinical staff - are made fully aware of their responsibilities and obligations to respect patient confidentiality.

Principle 6 - Comply with the Law

Every use of personal confidential data must be lawful. Someone in each organisation handling personal confidential data should be responsible for ensuring that the organisation complies with legal requirements.

Principle 7 - The Duty to share Information Can Be As Important as the Duty to Protect Patient Confidentiality

It is essential that HCPs have the confidence to share information in the best interests of their patients within the framework set out by these principles. Clinical governance systems should be in place with policies and procedures to support HCPs.

The General Data Protection Regulation (GDPR) is an EU Regulation in place in the UK since 25 May 2018. The GDPR and Data Protection Act 2018 (DPA) replace 1998 Data Protection Act but the key principles of the original Act remain and apply to doctors working in the NHS in the UK (in primary or secondary care) or private practice. GDPR applies to both digital and physical (paper) records and information is subject to confidentiality obligations that already exist, e.g. between a doctor and patient.

Compliance must be actively demonstrated, for example it will be necessary to keep and maintain up-to-date records of the data flows from a practice and the legal basis for these flows; and have data protection policies and procedures in place. Furthermore more information is required in ‘privacy notices’ for patients; there is legal requirement to report certain data breaches; significantly increased financial penalties for breaches as well as non-compliance; no charge allowed for patients to access medical records (save in exceptional circumstances); designation of Data Protection Officers [57].

Particular care must be taken to ensure appropriate measures are in place to ensure confidentiality of electronic records, for example having restricted access levels for different users according to need, password protection, and encryption of portable data, for example, memory sticks. HCPs are encouraged to seek advice on specific issues relating to record keeping from their defense organization or local Caldicott guardian.

The Information Commissioner's Office (ICO) is the authority responsible for upholding information rights in the UK. Detailed guidance on complying with the data protection law is available on the ICO website: https://ico.org.uk/ HCPs who handle personal data must be registered with the IC unless covered by their employer. For doctors, and other HCPs, working in the NHS there are well established arrangements for the management and storage of clinical notes. Doctors and other HCPs who are independent practitioners, or who work for private companies commissioned to provide clinical forensic medical services, whether employed or self-employed, should be aware of appropriate policies and procedures to manage notes and computerized records. Notes should be stored securely whether this is the physical storage of records as well as electronic security. Material stored on electronic devices (especially portable devices) should be password-protected and properly encrypted, and of course electronic records should be backed up regularly (and backups encrypted and stored securely – preferably away from the main site) [58].

Comprehensive notes assist in the care of the patient, especially when HCPs work in teams or partnership and share the care of patients with colleagues. Notes then help to keep colleagues well informed. Good notes are invaluable for forensic purposes; there may be a substantial delay in requests for statements or court appearances. When the HCP faces a complaint, a claim for compensation, or an allegation of serious professional misconduct or poor performance, comprehensive notes are invaluable when defending such cases. The medical defense organizations have long explained that an absence of adequate notes may render indefensible that which may otherwise have been defensible. The existence of full and accurate contemporaneous notes is often the key to preparing and mounting a successful defense to allegations against a doctor or the institution in which he or she works.

Notes should record facts objectively and dispassionately; they must be devoid of pejorative comment, wit, invective, or defamation. Patients and their advisers now have increasing rights of access to their records and rights to request corrections of inaccurate or inappropriate information.

Access to Health Records

Access to medical and other health records, which is provided for by statute law, varies considerably from one jurisdiction to another. A health record exists to provide an account of a patient's contact with the healthcare system and consists of information relating to the physical or mental health or condition of an individual made by a health professional in connection with the care of that individual [48]. Under the DPA 2018, patients have the right to request access to their own medical records under a Subject Access Request (SAR) without charge, including situations where they give consent for a third party, such as a solicitor or insurer, to access the data. Unfortunately, space considerations do not permit an explanation of the detailed statutory provisions; readers are respectfully referred to local legal provisions in their country of practice. The BMA have produced comprehensive guidance for health professionals in the UK on managing requests for access to health records [48].

Preparation of Reports

HCPs regularly receive requests to produce reports for medicolegal reasons. They should understand the basis for this and what is required—a simple report of fact based on their professional involvement in a case, a condition and prognosis report after a medical examination, an expert opinion, or a combination of these. Although the HCP may possess certain expertise, this does not necessarily mean the court will designate him an expert on every occasion.

A report may be required for a variety of reasons, and its nature and content must be directed to the purpose for which it is sought. Is it a report of the history and findings on previous examination because there is now a criminal prosecution or civil claim? Is an expert opinion being requested based on the clinical notes made by others? Is it a request to examine the patient and to prepare a report on present condition and prognosis? Is it a request for an expert opinion on the management of another practitioner for the purposes of a medical negligence claim?

The request should be studied carefully to ascertain what is necessary and clarification sought where necessary in the case of any ambiguity. The fee or at least the basis on which it is to be set should also be agreed in advance of the preparation of the report. If necessary, the appropriate up-to-date consents should be obtained and issues of confidentiality addressed.

Reasonable care must be taken in the preparation of any report. Any dishonesty in a signed statement amounts to perjury and may lead to prosecution. A medicolegal report may affect an individual's liberty in a criminal case or compensation in a personal injury or negligence action. A condemnatory report about a professional colleague may cause great distress and a loss of reputation; prosecuting authorities may even rely on it to decide whether to bring homicide charges for murder ("euthanasia") or manslaughter (by gross negligence). Reports must be fair and balanced. Any expert should be independent and impartial. The HCP is not an advocate for a cause, but should see their role as assisting the court in determining the outcome of a case by clarifying the relevant medical issues. It must always be considered that a report may be disclosed in the course of legal proceedings and that the author may be cross-examined about its content, on oath, in court, and in public. A negligently prepared report may lead to proceedings against the author, perhaps even referral to the regulatory body and criminal proceedings in exceptional cases. Certainly, a civil claim can be brought if a plaintiff's action is settled on disadvantageous terms as a result of a poorly prepared opinion. There is also the attendant risk of adverse judicial comment and as a result, a requirement to report oneself to the GMC [34]. Press publicity which may significantly affect that doctor's status in respect to any future instruction.

The form and content of the report will vary according to circumstances, but it should always be well presented with relevant dates and details carefully documented in objective terms. Care should be taken to address the questions posed in the letter of instructions from those who commissioned it. It is acceptable for the report to be submitted in draft form before it is finalized, but the HCP must always ensure that the final text represents his or her own professional views and must avoid being persuaded by counsel or solicitors to make amendments which he believes cannot be justified: it is the HCP who will have to answer questions in the witness box which may be felt as the loneliest place in the world if he or she makes claims outside the area of expertise or in any way fails to "come up to proof" (i.e., departs from the original statement).

Health care professionals (doctors, nurses and paramedics) working in the fields of general forensic medicine and sexual offence medicine will commonly be asked to provide professional witness statements following their examination of a detainee, complainant/complainer, or police officer. It is essential that the statement details the history and examination findings and provides an appropriate opinion dependent on the significance of the clinical findings and the knowledge, skills, experience and qualifications of the HCP. The language used should be understandable to a lay person sitting in the jury. The FFLM recommends that HCPs state in their professional witness statements:

'*This is a professional witness statement of fact. I am able/unable to provide expert opinion evidence in relation to this matter and will be happy to do so on supply of all relevant documentation*' [59].

Five categories of evidence have been outlined [60]:

- expert evidence of opinion on facts produced before the court;
- expert evidence to explain technical subjects or the meaning of technical words;
- evidence of fact given by an expert the observation comprehension and description of which require expertise; (often referred to as professional witness evidence)
- evidence of fact given by an expert which does not require expertise for its observation, comprehension, and description, but which is necessary preliminary to the giving of evidence in the other four categories;
- admissible hearsay of the specialist nature.

In England and Wales those who are required to give, or prepare, expert evidence for the purposes of criminal proceedings must do so in accordance with the Criminal Procedures Rules and the Criminal Practice Directions [61]. The Practice Direction states that an expert report should include the following declaration:

'I confirm that I have acted in accordance with the code of practice or conduct for experts of my discipline, namely [identify the code].'

The FFLM has produced a Code for their Members [62]. The GMC also provides guidance for doctors "Acting as a Witness in Legal Proceedings" [63]. Guidance has been provided for all healthcare professionals by the Academy of Medical Royal Colleges [64].

Expert Statements/Certificates - Maria Nittis

"The overriding objective of this procedural code is that criminal cases be dealt with justly. Dealing with a criminal case justly includes acquitting the innocent and convicting the guilty, dealing with the prosecution and the defence fairly, recognising the rights of the defendant…" [65].

The primary duty of an expert witness is to the court and never as a patient advocate. The goal for the expert should not be to win the case, assist the prosecution or thwart the defense (or vice versa). The expert should be mindful that their role is to assist the court in understanding what happened, what was found, and what can be reasonably concluded from those findings.

Legislation relating to expert evidence, and the admission thereof, is likely to differ between jurisdictions. In the United States, it is largely derived from two landmark cases in 1923 and 1993. In 1923, a significant decision was made in *Frye v. United States* [66]. Evidence, in the form of a lie detector test that measured systolic blood pressure, was rejected because the court reasoned that the principle being used must be recognized and "sufficiently established to have gained general acceptance in the particular field in which it belongs." [67] (p88).

Seventy years later, in 1993, in *Daubert v. Merrell Dow Pharmaceuticals, Inc.* [68], it was decided that for scientific testimony or evidence to be admitted it had to not only be relevant but reliable [67] (p.90). In using this as an evidentiary standard, courts should consider whether a theory or technique has been tested, subject to peer review and publication, there is a known rate of error in the scientific technique, there are standards controlling the technique's operation and there is a degree of acceptance within a relevant scientific community [67] (p 91). In 2000 this was amended. Commentary accompanying the revised evidentiary rules stated that:

"*If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training or education, may testify thereto in the form of an opinion or otherwise, if* (1) *the testimony is based upon sufficient facts or data* (2) *the testimony is the product of reliable principles and methods and,* (3) *the witness has applied the principles and methods reliably to the facts of the case*" [69].

The *Daubert* decision observed that '*there are important differences between the quest for truth in the courtroom and the quest for truth in the laboratory. Scientific conclusions are subject to personal revision. Law, on the other hand, must resolve disputes finally and quickly*' [68].

Herein, no doubt, lies many of the difficulties forensic examiners face when attending Court as Experts.

While a considerable amount of the layout, content and expectations for these expert statements is legislated or governed by professional codes [70] there are some common themes that should be considered when preparing a statement or expert report/certificate.

Edmond et al. [71] have suggested that the expert should consider four things when writing a statement: disclosure, transparency, epistemic modesty, and impartiality. The article was aimed at forensic science practitioners but is nonetheless applicable to other areas of expertise such as the forensic HCP.

"*Reports and testimony should be transparent. They should enable others, both the technically proficient and the technically challenged, to review and understand how the evidence was collected, processed and analyzed, how particular conclusions were reached, and provide insight into uncertainties and limitations with these processes and conclusions*" [71].

"*An expert report should be sufficient to enable another expert or scientist to make a clear assessment of the analysis and conclusion*" [71].

The authors go on to recommend that opinions of forensic practitioners should be epistemologically modest, avoid over-claiming or exaggerating performance, and act in a way that is consistent with "demonstrated ability". Examiners should concede limitations and uncertainties.

The examiner must not select findings or results to support their opinion or otherwise "*misrepresent, or mislead as to, individual findings or overall conclusions*" [62].

"*In the absence of scientific research, there will normally be a widespread need for caution—a need to moderate confidence and strength of opinion*" [71].

In most Australian jurisdictions expert evidence admissibility is regulated by uniform evidence legislation which requires firstly that the witness has specialized knowledge based on their training, study or experience and secondly that their opinion is based "wholly or substantially" on that knowledge [71]. Each Expert report, therefore, should address both aspects of this requirement.

The forensic examiner should be engaged in a process of continuing professional development in order to demonstrate continued competency in their area of expertise [62].

There must be regard to any potential conflict of interest and instructing parties must be informed of this as soon as practicable [62].

Bias - Maria Nittis [72]

At least 24 different cognitive biases have been identified. Cognitive bias is where a subjective assumption is made based on one's own perception of reality. They can often be unconscious. Every HCP who works at the medicolegal interface should be aware of the relevant ones as they can influence decision making and opinions. As discussed previously, an Expert's opinion should be based on facts, data, reliable principles and methods. Below are only a few of the identified cognitive biases:

- Confirmation bias: Looking for ways to justify existing beliefs. We are primed to see and agree with ideas that fit our preconceptions. It is important to try and identify preconceptions and whether they are based on available evidence.
- Dunning-Kruger effect: the more you know the less confident you will be. The opposite, however, is often true. A person can be over-confident when they only have a simple idea of how things are.
- Just world hypothesis: a preference for a just world makes you presume that it exists e.g. all complainants tell the truth, all accused are guilty, all injuries are from non-consensual activities, all police are hard-working, objective and honest etc.
- Halo effect: Your judgement of another can be influenced by how much you like them or how attractive they are e.g. they are professionals with good jobs and highly respected in the community therefore they must be telling the truth. Alternatively, they are a drug using sex-worker and so their history is questionable.
- Availability heuristic: Recent, emotionally powerful or unusual memories can seem more relevant and cause you to apply them too readily i.e. you place greater value on things that come to your mind more readily.
- Group think: Dissent can be uncomfortable and dangerous to one's social standing and so often the most confident or first voice will determine group decisions.
- Affinity bias: leads us to favour people who are like us
- Misinformation effect: this is the tendency for post-event information to interfere with the memory of the original event. Your memory can be influenced by what you hear about the event from others.

Peer Review

Peer review has been defined as the evaluation of work or performance by colleagues in the same field in order to maintain or enhance the quality of the work or performance in that field [73]. In the context of peer review, peer is used to refer to people in the same profession who are of the same or higher ranking.

The expectation that there should be peer review of a statement, prior to its submission to court, is likely to increase. Peer review may occur in different ways. A reviewer may read a statement and offer comments about grammar, spelling and the opinion reached based on the evidence cited in the certificate / statement. A reviewer may, however, additionally review contemporaneous material collected at time of examination, for example original injury diagrams, patient histories and photographs. It is the latter, arguably, which could allow the reviewer to reach an independent assessment of the information that was available to the primary examiner. If a statement has been peer reviewed, should this be identified within the statement? Should a list of the materials reviewed be specified? Should difference of opinions be recorded for the court and when should this be done? Should reviewed drafts of statements be kept and presented to court upon demand? It is likely that examiners who work within sexual assault units will need to consider the pros and cons of each course of action and develop guidelines for staff to ensure a consistent and transparent approach.

There are clear benefits for healthcare professional working in the forensic environment to discuss cases and learn from others but there are also legal implications which will vary in different jurisdictions and HCPs need to be aware of the requirements in relation to the disclosure of unused material [73].

Attendance at Court

Generally, courts consist of two types: criminal and civil. Additionally, the HCP will encounter the Coroners Court (or the Fatal Accident Inquiry at the Sheriff Court in Scotland), which is, exceptionally, inquisitorial and not adversarial in its proceedings. A range of other special courts and tribunals exists, from ecclesiastical courts to social security tribunals; these are not described here.

It is possible for a HCP to be called to any court to give evidence. The type of court is likely to depend on the HCP's practice, specialty, and seniority. The HCP may be called to give purely factual evidence of the findings made in the course of his practice, in which case the HCP is simply a professional witness of fact, or to give an opinion on some matter, in which case the HCP is an expert witness. Sometimes, the HCP will be called to give both factual and expert evidence.

Normally, an HCP will receive adequate notice that attendance in court is required and he or she may be able to negotiate with those calling him or her concerning suitable dates and times. Many requests to attend court will be made relatively informally, but more commonly a witness summons will be served. It is essential to cooperate with police and police staff in relation to attending court as any reluctance to attend court may well result in a formal summons, which compels the HCP to attend or to face arrest and proceedings for contempt of court if the HCP refuses.

If the HCP is reasonable and responsible it is likely that there will be sympathetic understanding and cooperation of the lawyers and the court in arranging a time to give evidence that least disrupts clinical practice. However, any exhibition of belligerence by the HCP can induce a rigid inflexibility in lawyers and court officials – who always have the ability to "trump" the doctor by the issuance of a summons, so be warned and be reasonable.

Evidence in court is given on oath or affirmation. The HCP will usually be allowed to refer to any notes made contemporaneously to "refresh the memory," although it is courteous to seek the court's agreement.

Demeanor in Court

The limited space available does not permit more than to outline good practice when giving evidence. Court appearances should be taken seriously as an individual's liberty may be at risk or significant damages and costs may rely on the evidence given. The HCP's dress and demeanor should be appropriately professional, and he or she should speak clearly and audibly.

Before attending court ensure that you have your notes, statement/report and any other relevant paperwork relating to the case. Review the notes and statement/report considering the key strengths and weaknesses. Whether it be evidence in chief or cross-examination, it is worth listening attentively to the questions posed. Consider carefully the proposed response prior to speaking. Answer the question asked (not the one you think it should have been) concisely and carefully, and then wait for the next question. The role of the HCP is not to fill a gap in the conversation; the judge and others will be making notes, and it is wise to keep an eye on the judge's pen/keyboard and adjust the speed of your words accordingly. Pauses between questions allow the judge to finish writing or counsel to think up his or her next question. If anything you have said is unclear or more is wanted from you, be assured that you will be asked more questions. If there is a straightforward answer, then give it unless the outcome would mislead the court. Brevity has much to commend it, although answering in monosyllables is unlikely to help the court. Be calm and patient, and never show a loss of temper or control regardless of how provoking counsel may be. An angry or flustered witness is a gift to any competent and experienced counsel, as is a garrulous or evasive witness. It is perfectly permissible to ask for a question to be repeated as long as this strategy is not repeated ad nauseam.

Try to use simple language devoid of jargon, abbreviations, and acronyms. Stay well within your area of skill and expertise and do not be slow to admit that you do not know the answer. Your frankness will be appreciated, whereas an attempt to bluff or obfuscate or overreach yourself will almost certainly be detrimental to your position.

HCPs usually seek consensus and try to avoid confrontation (at least in a clinical setting). They should remember that lawyers thrive on the adversarial process and are out to win their case, not to engage on a search for truth. Thus, lawyers will wish to extract from witnesses answers that best support the case of the party by whom they are retained. However, the medical witness is not in court to "take sides," but rather to assist the court, to the best of the expert witness' ability, to do justice in the case. Therefore, the witness should adhere to his or her evidence where it is right to do so, but must be prepared to be flexible and to make concessions if appropriate, for example, because further evidence has emerged since the original statement was prepared, making it appropriate to cede points. The HCP should also recall the terms of the oath or affirmation—to tell the truth, the whole truth, and nothing but the truth—and give evidence accordingly.

The Duties of Expert Witnesses

Pitfalls

There are many potential pitfalls in forensic medical practice and while most may be avoided by an understanding of the legal principles and forensic processes, this is now a topic of postgraduate rather than undergraduate education. The typical "doctor–patient" relationship does not apply; the detainee needs to understand the role of the doctor or other HCP and the relevant explanation provided to ensure any consent is informed in nature.

Meticulous attention to detail and a careful documentation of facts are required at all times. You will never know when a major trial will turn on a small detail that you once recorded (or, regrettably, failed to record). Your work will have a real and immediate effect on the liberty of the individual and may be highly influential in assisting the prosecuting authorities to decide whether to charge the detained person with a criminal offense.

As an HCP you clearly owe a duty of care to those who engage your services, for that is well-established law. The issue of whether a forensic physician (FP/FME forensic medical examiner) owes a wider duty to the victims of alleged crime was decided in the English Court of Appeal during 1999 [74]. A doctor working as an FME examined the victim of an alleged offense of rape and buggery (sodomy). The trial of the accused offender was fixed, and all prosecution witnesses were warned and fully bound, including the FME.

The trial was scheduled to begin on December 7, and on December 6, the FME was warned that she would not be required to attend on the first day of trial but would be needed some time after that. The trial commenced on December 7, and the accused pleaded not guilty. On Friday, December 8, the FME was told that she would not be needed that day but would be required the following week. She did not state that this would cause any problem. However, on December 11, the FME left the country for a vacation. On December 14, the police officer in charge of the case spoke by telephone with the FME. She said she could not return to give evidence before December 19. The remainder of the prosecution case was finished on December 14. The trial judge refused to adjourn the case until December 19. On December 20, the judge accepted a defense submission of no case to answer and directed the jury to return a verdict of not guilty. A few weeks later, the FME was convicted of contempt of court for failing to attend court to give evidence, and she was fined.

The female victim commenced civil proceedings against the FME, alleging negligent conduct in failing to attend, as warned, to give evidence. In her claim, the claimant asserted that if the FME had given evidence (presumably in accordance with her witness statement), the trial judge would have refused the defense submission of no case to answer. The claimant also contended that on the balance of probability, the accused would have been convicted because the FME's evidence would have undermined the credibility of the accused's defense that no anal interference had occurred. The claimant claimed that the FME owed her a duty of care to take all reasonable steps to provide evidence of the FME's examination in furtherance of the contemplated prosecution and to attend the trial of the accused as a prosecution witness when required. She claimed to suffer persistent stress and other psychological sequelae from failing to secure the conviction of her alleged assailant and knowing that he is still at large in the vicinity.

The claimant did not contend that there was any general duty of care on the part of a witness actionable in damages at the suit of another witness who may suffer loss and damage through the failure of the first witness to attend and give evidence in accordance with his or her witness statement.

When the case came before the Court of Appeal, Lord Justice Stuart-Smith stated that the attempt to formulate a duty of care as pleaded,

> is wholly misconceived. If a duty of care exists at all, it is a duty to prevent the plaintiff from suffering injury, loss or damage of the type in question, in this case psychiatric injury. A failure to attend to give evidence could be a breach of such duty, but it is not the duty itself.

Later, Lord Justice Stuart-Smith stated:

> it is quite plain in my judgment that the defendant, in carrying out an examination at the behest of the police or Crown Prosecution Service, did not assume any responsibility for the plaintiff's psychiatric welfare; the doctor/patient relationship did not arise.

He concluded his judgment:

> it is of no assistance to the plaintiff here in trying to construct a duty of care to attend court to give evidence which, as I have already pointed out, could amount to breach of a wider duty which is not alleged and could not be supported.

The other two Lords Justice of Appeal agreed. Lord Justice Clarke observed that:

> In (the circumstances of the case) any duty of care owed (by the FME) must be very restricted. It seems to me that she must have owed a duty of care to carry out any examination with reasonable care, and thus, for example, not to make matters worse by causing injury to the plaintiff. It also seems to me to be at least arguable that where an FME carries out an examination and discovers that the person being examined has, say, a serious condition which needs immediate treatment, he or she owes a duty to that person to inform him or her of the position.

The claimant's action against the FME for damages was dismissed, and it was confirmed that there was no duty of care owed by the FME to the victim to attend the trial as a prosecution witness when required.

Key Points

- Ensure that you keep clear, detailed, contemporaneous notes of your interaction and assessment with any patient. Your notes will be essential should there be a complaint about a patient's care, for writing a statement based on your assessment, and if you have to attend court as a professional witness
- Before attending court review your notes and statement/report considering the key strengths and weaknesses

Self-Assessment Exercises

1. When can a health care professional breach patient confidentiality?
2. What are the five statutory principles set out in the Mental Capacity Act?

3. Who has parental responsibility for a child?
4. How may bias affect decision making?

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Sexual Assault Examination

3

Maria Nittis

Learning Objectives
Knowledge of the types of injuries that may occur following sexual assault.

Management of the forensic assessment, including the taking of a forensic history and obtaining consent.

Demonstrate the importance of contamination reduction.

Ability to select the appropriate evidence-based samples based on the information provided by the complainant, witnesses, and police.

Knowledge of the evidence that underpins forensic collections and the timing of those collections.

Ability to provide appropriate aftercare including emergency contraception, post exposure prophylaxis.

Definitions

Sexual Assault has a legal definition which can vary across different jurisdictions. It is important that an examiner is very familiar with the legal definition in their area.

In the U.K., for example, "Sexual Assault" occurs if a person (A) intentionally touches another person (B), the touching is sexual and (B) does not consent. "Rape" occurs if person (A) penetrates the vagina, anus or mouth of another person (B) with his penis and (B) does not consent. There is another category called "Assault by penetration" which occurs if person (A) intentionally penetrates the vagina or anus of another person (B) with a part of his body or anything else, the penetration is sexual and "B" does not consent [1].

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In the Republic of Ireland, "Rape" is defined as having occurred if a man has unlawful sexual intercourse with a woman who does not consent [2]. "Rape" is defined as the penetration (however slight) of the anus or mouth by the penis or penetration (however slight) of the vagina by any object held or manipulated by another person [3]. "Sexual Assault" is reserved for non-penetrative events (as above) and is defined as any indecent assault perpetrated on a man or a woman.

In Scotland a "Sexual Assault" occurs if a person (A), without consent of person (B), does any of the following [4]:

- Penetrates sexually by any means and to any extent the vagina, anus or mouth of (B)
- Intentionally or recklessly touches (B) sexually
- Engages in any other form of sexual activity in which (A) has physical contact with (B) (whether bodily contact or contact by means of an implement and whether or not through clothing)
- Intentionally or recklessly ejaculates semen onto (B)
- Intentionally or recklessly emits urine or saliva onto (B) sexually

The definition of "Rape" is when a person (A) penetrates to any extent, with their penis and without the consent of (B), the vagina, mouth or anus of (B) [5].

In NSW, Australia, the term "Sexual Assault" is equivalent to "Rape" in the above legislations (even if penetration is by an object) while all other assaults of a sexual nature, without penetration, are termed "Sexual Touching." Sexual touching replaced the term "Indecent Assault" in December 2018 [6].

Introduction

Sexual Assault Services may be independent, stand-alone services that provide dedicated assessment, care and forensic sampling for complainants of sexual assault. The services may cater for males and females; pediatric and adult cases. They may have dedicated space in which to conduct these examinations. They may see all complainants, even those who do not wish to disclose the assault to police. They may supply additional services such as counselling, psychology, advocacy and / or support people to assist the complainant. The unit may provide ongoing sexual health screening as required. Or they may not. If you are an examiner, or just wishing to know how sexual assault services might work, this chapter aims to provide an overview of such facilities and aims to assist the examiner, working in the field of sexual assault, in providing an evidence-based forensic medical assessment.

Sexual assaults create significant health and legislative problems for every society. All health professionals who have the potential to encounter victims of sexual assault should have some understanding of the acute and chronic health problems that may ensue from an assault. An examiner must have knowledge of the relevant sexual assault legislation in the jurisdiction within which they work, understand the admission and exclusion criteria which operates and be familiar with any cut off time periods for forensic sampling.

This chapter will not cover the epidemiology of sexual assault, as this has been covered extensively elsewhere, other than to state that it is a prevalent crime affecting more people than reports made to police. It affects men and women, girls and boys as well as those who identify as trans and intersex. It affects homosexuals, heterosexuals and bisexuals. It is seen in every culture, every community and across all religious denominations. “Despite its destructiveness, violence is ubiquitous in society” [7]. It has the ability to impact a person’s life for the rest of his/her life. The aim of most sexual assault services is to reduce the psychological impact, restore a sense of power, control and choice, ensure all medical needs are met, provide forensic assessment and collection of evidence to the best standard possible and to assist the complainant to navigate their way through the process.

The following sections will include an overview of the relevant anatomy, development, and physiology. Injury and injury documentation will be covered. The practical aspects—which samples to obtain, when and how to obtain them, will also be addressed.

Throughout all the stages of the clinical forensic assessment, the forensic practitioner must avoid partisanship while remaining sensitive to the immense psychological and physical trauma that a complainant may have incurred. The continuing care of the complainant is essentially an ongoing process throughout and beyond the primary clinical forensic assessment.

While reference is made to the sexual assault “complainant” other terms that might equally apply include victim, patient, client or complainer.

While this chapter hopes to support an examiner tasked with performing sexual assault assessments it does not replace the specialist knowledge, skills, and attitudes that can only be acquired through more formalized theoretical and practical training and ongoing peer review and mentorship.

Neuroscience

The neuroscience of fear and fear reactions is still not completely understood. The brain is a complex and inter-related system which is affected by individual past experience as well as primary genetics. The following information is a very general outline of some of the current neuroscientific principles associated with fear and the fear response. It is hoped that a sexual assault examiner, by understanding these basic principles, might better understand the variability of presentations by complainants at time of examination (e.g. traumatized, distressed, absent, unperturbed etc.) and why there may be difficulties in trying to gain a cogent version of events.

It is thought that sensory information (sight, touch, smell, sound, taste) is transmitted to the thalamus. This information is then transmitted to other relevant areas of the brain for processing. When the thalamus does not function as it should (as may occur as a result of a flooding of the thalamus with stress hormones e.g. as a result of trauma), there can be interference with the way a person remembers the trauma i.e. they may not recall an event in an integrated or chronological way but, rather, remember it as a series of images, sounds and sensations associated with intense emotions [8].

The thalamus is thought to be responsible for sending information to the amygdala (which lies in the limbic, unconscious brain) and to the frontal lobes (conscious brain). The road to the amygdala is extremely fast. If the amygdala interprets this information as a threat, this information is sent to the hypothalamus and brain stem resulting in the release of stress hormones such as cortisol and adrenaline. There is engagement of the autonomic nervous system (sympathetic pathway) which can result in an increase in blood pressure, heart rate, respiratory rate, body temperature, and slow down of both urination and defecation. There can be dilation of airways, increase in heart contraction, increased muscular action, sweating of palms, dilation of pupils and piloerection.

This reaction, however, can be modulated by the frontal lobe (particularly the medial prefrontal cortex) which allows for assessment of the situation [8]. In low to moderate stress levels, the prefrontal cortex can act to "calm down" the amygdala. In an "amygdala hijack", where there is an extreme stimulus, the amygdala shuts off the prefrontal cortex function (where conscious control and decisions are made). It is an evolutionary response to a risk environment where there is no time for thought.

The hippocampus attempts to regulate the fear response, lessening it when the danger has passed. Like the thalamus, it has a key role in the development of and in the processing of memory. If overwhelmed by stress hormones, it too can result in disorganized or fragmented memories.

Neuropsychology of Trauma

The phrase "fight or flight" was coined in 1929. For many who do not work with sexual assault complainants, it can be easy to assume that most victims of assault would seek to escape or offer some form of resistance. Much work has been done in the years since 1929 and it has been postulated that there are essentially four distinct fear responses. There is an initial freeze response (this has been referred to as the stop, look, listen response). It is a state of hyper vigilance. The next response is to flee or leave the situation. If this is deemed impossible the next response is to provide some form of resistance (or fight). Hence it might better be referred to as the flight or fight response (order reversed). The last response is tonic immobilization [9] (freeze, flight, fight, frozen?).

Möller et al. [10] reviewed 298 women who had presented to a sexual assault clinic. 70% of those women reported significant tonic immobility (using the tonic immobility scale-adult form–TIS-A) and 48% reported extreme tonic immobility during the assault. This has been described as an involuntary, temporary state of motor inhibition in response to extremely fearful situations that can, not only, prevent someone from being able to move but may cause them to shake, prevent them from screaming out, and lead to feelings of detachment from the ongoing event. Interestingly, alcohol intake within the previous 12 h before the assault reduced the risk of tonic immobility by half!

Tonic immobility was associated with the development of post-traumatic stress disorder and severe depression. Not surprisingly, previous trauma history and psychiatric treatment history were both associated with the tonic immobility response [10].

Whether a person has experienced freezing, chosen to attempt an escape or provide resistance, or whether they have found themselves traumatically immobile as a result, an examiner should be aware that these responses are quite individual, may not be the same if they were to be sexually assaulted on another occasion, and the complainant may have very little conscious control over any of these reactions. That is, what we think we might do, if we found ourselves in such a situation, may not bear any resemblance to what we actually do.

Complainants of sexual assault should be offered counselling to help them cope with the recognized immediate and long-term psychological sequelae of a sexual assault [11]. Some examination facilities have 24-h access to trained counsellors [12].

Illustrative Case *During a Sydney trial in October 2016, a jury heard details of how a NSW girl had suffered torture and sexual assaults, as she was growing up, by her father and assisted by her mother. Richard Guilliatt, journalist at The Australian, spoke to a woman who had known the family for 15 years. She is reported to have said, "I don't believe any of it…Honestly, I can't see it." Another mother told Richard, "I don't know anyone who knew them and trained with them who thinks this happened." The parents' middle daughter and son also deny the accusations. The middle daughter said that her youngest sister had been diagnosed with Dissociative Identity Disorder and "began to recollect memories that no one else in the family had…my sister is as much a victim as anyone. All I know is that she was admitted into the mental health system and we lost her." Her father was found guilty and sentenced to 48 years in prison. Her mother was sentenced to 16 years* [13].

Medical Examination

Basic Principles

A clear referral pathway should be identified for complainants of sexual assault. All complainants should have immediate triage assessment which includes recording of blood pressure, temperature, pulse rate and a Glasgow Coma scale ranking. Injuries should be identified and triaged. Issues with consent (decreased/altering consciousness, mental health, intellectual and developmental delay, age, intoxication etc.) should be ascertained and substitute consent obtained if required. The health of a patient takes priority. Working closely with treating staff can ensure that medical care is provided in a timely manner and evidence can be preserved where possible.

Examiners should aim to look at all body areas, when conducting a sexual assault assessment, in order to record injury or sites of pain and tenderness. Dependent upon the history given they should be able to competently use an auroscope, ophthalmoscope, speculum, proctoscope (anoscope), colposcope and camera or there should be a clinician available who can assist with these examinations if required.

Prior to any body part examination, the examiner should ensure they have the complainant's ongoing consent to proceed. An examiner should, at all times, be mindful to protect and preserve the dignity and privacy of the patient, exposing only those parts of the anatomy being examined at any one time.

Assessment for intoxication should be done when there is a history of recent drug or alcohol use.

Timing of the Examination

Although in general terms the clinical forensic assessment should occur as soon as possible, reference to the persistence data given under the relevant sections and the acute medical needs of the patient will help the forensic examiner determine whether the examination of a complainant should be conducted as soon as possible, may be deferred or should not be undertaken at all. Even when the nature of the assault suggests there is unlikely to be any forensic evidence, the timing of the examination should be influenced by the speed with which any clinical signs if present, such as superficial/minor injuries, might disappear.

Detaining police personnel should be consulted prior to making the decision regarding the timing of a suspect examination.

Place of the Examination

Specially designed facilities used exclusively for the examination of complainants / suspects of sexual offences are available in many countries. Furnishings in these units should be durable and suitable for cleaning between examinations [14]. The complainant may wish to have a support person present for all or part of the examination, and this wish should be accommodated if practical. The presence of this additional individual should be recorded in the event that a DNA elimination sample is needed from them at a later date. Suspects are usually examined in the clinical room of the police station and a same-sex chaperone should be present.

During the examinations of both complainants and suspects, the local ethical guidance regarding the conduct of intimate examinations should be followed [15].

Contamination Reduction

Advances in DNA analysis and trace evidence bring with them increased responsibility for examiners. Of course it is virtually impossible to eliminate all extraneous DNA but effort should be made, and these efforts should be documented where appropriate, to reduce the potential for contamination of evidence.

"In the examination process the principle is to minimize the inadvertent transfer of DNA material that could lead to the miscarriage of justice" [16].

Contamination has been an issue in many high-profile cases including Farah Jama (Australia) [17], the Avenger of Zuuk (Netherlands) [18] and Adam Scott

(Manchester) [19]. This has resulted, over the last several years, in an increasing number of cases where the question is not just "whose DNA is it" but "how or when did it get there" [20].

All Sexual Assault units should have protocols/guidelines which address the issues surrounding contamination reduction.

Sources of contamination may include:

- DNA from the examiner. This can occur by breathing over specimens, touching swab tips etc.
- DNA from previous complainant/s. This can occur if examination surfaces are not adequately cleaned and prepared.
- DNA from other people who have entered the room e.g. cleaners, complainant's support people, counsellors, police etc.
- DNA from previous samples
- DNA from other people the complainant has been in contact with or from contact with surfaces that have been touched by other people e.g. in ED waiting rooms, ambulances, police cars etc.
- In the laboratory

Washing provides a first and preliminary level of cleaning. The act of washing hands or equipment will remove some DNA simply by the mechanical process involved. The act of washing itself, however, will not provide a sterile environment and it does not provide a DNA free space.

Using "single use" equipment is preferential to multiuse equipment. Single use items may be both clean and, in some cases, sterile but they may not necessarily be DNA free. Equipment that must be re-used, for example a camera or computer, should be decontaminated between each examination [16].

Bleach (0.5% sodium hypochlorite) is one of the most effective agents for denaturing DNA. Many units are hesitant to use this contamination reduction agent because of the attendant occupational health and safety issues associated with it. It can potentially damage sensitive equipment (such as colposcopes or cameras). There are some alternate detergent/decontaminants available e.g. Virkon™ [21], Virachlor™, Actichlor™, that offer combined sterilization along with some DNA decontamination.

Ethylene oxide (a gas) is commonly used for the sterilization of medical equipment. It is a bactericidal, fungicidal and sporicidal disinfectant that is damaging to DNA. It is also used, therefore, to sterilize swabs and forensic evidence kits to reduce the incidence of background DNA contamination.

In the UK, the Forensic Science Regulator [22] provides guidance as to DNA free consumables, guidance for Sexual Assault referral centers as well as to cleaning and environmental monitoring (pending at time of writing).

Some forensic laboratories may request the voluntary submission of examiner DNA to help eliminate accidental upload to offender databases if contamination does occur.

Securing a dedicated area for seeing complainants of sexual assault will further reduce chances of cross contamination. Thought should be given to maintaining a register to record anyone who accesses the area and those present during forensic examinations. Evidence kits should be sealed to prevent interference or reuse. Any unused items should be discarded, if open. Areas used for the storage and handling of consumables, samples and exhibits should be secure and access restricted to authorized personnel [16].

Powder free non-latex gloves should be easily accessible, worn by the examiner and replaced frequently during an examination. The powder in many types of gloves has been found to inhibit subsequent DNA analysis and therefore should be avoided [16]. Double gloving is recommended with regular changes of the top gloves when collecting different samples or examining different body areas. Some jurisdictions require that all used gloves should be retained and exhibited. Disposable plastic aprons and disposable sleeves are worn in some jurisdictions. In addition, the forensic practitioner should avoid talking, coughing, or sneezing over unsealed samples and should handle all samples as little as possible. Face masks further reduce the potential for this occurring. Choices for personal protection equipment (PPE) should be made keeping in mind patient acceptability versus potential risk.

It is suggested that any professional statements/expert statements/certificates prepared by forensic examiners should have a section that relates to the methods used to reduce potential contamination. Should these processes have been compromised in any way, for example a swab head was accidentally touched by the examiner or dropped on the floor, full disclosure should be made to the laboratory and to the court.

Any furniture, for example examination beds, chairs and lounges, in the sexual assault unit should be cleaned with bleach or a recommended cleaning agent that denatures DNA, before the examination. A disposable examination bed cover should be used and fresh paper roll may be used as a "sheet" if a DNA free examination bed cover is not available.

Decontamination (deep) cleaning of the whole forensic area should be carried out at least monthly to remove build-up of DNA contamination [16].

Consent

A person is assumed to have the capacity to provide consent unless there is reasonable evidence to support that it is lacking or may be impacted in a significant way.

It is a fundamental legal principle that:

> *Every human being of adult years and sound mind has a right to determine what will be done with his own body; and a surgeon who performs the operation without his patient's consent commits an assault, for which he is liable in damages* [23].

In someone who has capacity, consent must be freely given (not coerced) and it must be informed. They must have an understanding of the procedure proposed, consequences of providing and withholding consent (i.e. undergoing or not undergoing the procedure) and this must be presented to the complainant in a way they can understand. Consent may be implied, verbal or written. Many sexual assault services, however, require consent for a forensic examination, releasing the information/forensic samples to third parties (e.g. police or forensic laboratories) and consent for imaging to be in writing. Despite having signed a consent form, the complainant can withdraw their consent for any part of the procedure at any time. Any withdrawal of consent should be documented.

Taking samples from suspects may require specific legislative authority [24]; the inspector's authority as well as the consent of the individual [25].

Consent should be reassessed and sought as the examination progresses and for each stage of the clinical forensic assessment, including the use of equipment (e.g. colposcope, camera, speculum, anoscope etc.).

Medical patients can rightfully expect that their personal health information will only be given to another person if this is important for their health care or can otherwise be justified legally and ethically. Health service providers owe patients a common law duty of confidentiality in relation to information obtained as part of the treating relationship. The duty, however, is not absolute. Confidentiality can be overridden when:

- The patient waives their right of confidentiality (or consents to its release)
- There is a valid court order or subpoena
- There are statutory provisions for mandated reporting e.g. in cases of child abuse and certain notifiable diseases
- There is an overriding "public interest" to do so (e.g. you have been informed that your patient intends to leave your office and murder someone)
- In some other emergency situations

Information obtained during a forensic assessment may not remain confidential if the complainant has waived this right of confidentiality by consenting for release of information/samples to a third party. The patient should be made aware that both the history and any other physical evidence collected, such as photographs, may eventually be made available to the court under these circumstances.

There may be examples of privileged information which are exempt, in legislation, from being disclosed in court. The examiner should be aware of these.

Obligations regarding confidentiality of information extend to the transfer of information. Steps must be taken to safeguard it and prevent inappropriate access. This includes transfer via mail, email, or fax. This is particularly relevant when you need to send statements or images to another person/agency. Do not discuss patient information in public areas where it is likely to be overheard.

Forensic photography is another aspect of forensic assessments that should not be done unless the proper consents have been obtained. Information that should be provided includes why the images are being taken, how they will be used (for what purposes), where they will be stored and for how long, who will have access (including the judicial system), and whether they will form part of a medical record [26].

Special consideration should be given to intimate images. These may include images (still or video) of the genitalia, breast, buttocks or anus. Some jurisdictions have legislation which controls how these images are viewed within a judicial setting. In all cases, every endeavor should be made to ensure they are viewed only by those who have a legitimate reason for doing so.

If a person is unable to consent, a substitute consenter or person with lasting power of attorney is often necessary. Legislation and policy in the different jurisdictions should outline who can provide consent in place of the patient and under what circumstances this can apply. Each examiner should be aware of the local guidelines relating to consent especially as it relates to the following category of complainants/suspects:

- Aged under 18 years
- Intoxicated
- Unconscious/impaired-consciousness
- Acute and significant mental health illness
- An involuntary mental health patient
- Significant intellectual or cognitive delay

If a person lacks capacity, consent from another person or organization may be required. Lack of capacity may be temporary (e.g. unconscious, intoxicated) or longer term (e.g. mental illness, significant intellectual impairment, dementia, brain damage, or underage). Where the impairment of capacity is likely to be short term, consideration should be given to delaying an examination until the person regains full capacity [27]. In such cases, the collection of early evidence (if possible) might be considered.

Even if a substitute consenter is required, available and provides their consent for examination or a procedure, it should not be undertaken if the complainant/suspect refuses the examination.

Chaperones

"A chaperone is an independent and impartial third person who is present during a physical examination in order to witness the conduct of the examination." A chaperone is not the same as a support person. As family and friends are often not independent they should not be used as chaperones [28].

A chaperone can serve several purposes. These include reducing the vulnerability (or feeling thereof) of a complainant and offering a measure of protection for the complainant and the examiner. When an intimate examination is conducted in the absence of a chaperone this should be documented in the medical records, inclusive of the reasons for the absence of a chaperone. Consideration should be given to postponing intimate examinations, if there will be no impact on the complainant's health, when the offer of a chaperone is declined [28].

An auditory chaperone, where the chaperone is not in the same room but in an adjacent space where they can hear, may be a viable alternative to having someone in the room itself. When examining a person of a different sex, it is recommended that the chaperone actually be present in the room.

Medical and Sexual History

A past medical history, current medications and any known allergies should be documented, as would be the normal practice for any medical examination. This information should not be included within a medical statement unless there is an obvious reason to do so. For example, some medical conditions can increase bruising e.g. liver failure. Some medications can do the same e.g. aspirin, anticoagulants, antidepressants as well as certain herbal medications. This information could be relevant when attempting to interpret mechanisms of causation for injuries seen.

Likewise, obtaining a complainant's recent sexual history may be relevant. This information may be used to exclude the DNA of anyone with whom the complainant had recent consensual intercourse. It may be relevant to interpretation of ano-genital injury. Once disclosed, the privacy of this information cannot be guaranteed and so caution should be used when seeking to obtain sensitive information.

Forensic History

The following aspects of an allegation should be ascertained:

- Time and date of assault,
- Time and date of forensic examination,
- Number of suspects,
- A list of all assaults (i.e. the assaults that are sexual, indecent or physical),
- Whether a condom was worn and whether ejaculation occurred (and where),
- Alcohol/drugs used (or suspected of having been used) that might affect consent for intercourse,
- Injuries or symptoms thought to have been sustained/occurred as a result of the assault/s,
- Any suspected memory loss,
- Whether any physical resistance was provided and
- Any other actions that might result in deposition of DNA from the offender onto the complainant's body (e.g. licking, biting, kissing, sucking, spitting, bleeding).

The relationship between the complainant and suspect might have significance for the forensic laboratory, for example if they lived together or are in a current relationship.

In some cases, when it is not immediately obvious to the examiner that a sexual assault (intercourse without consent) has occurred from the history given, an examiner might respectfully ask the complainant how the offender might have known that there was no consent. This can give a complainant the chance to explain what might have been said, what non-verbal clues might have been given or to describe why they did not feel able to verbalize the lack of consent if, in fact, that was the case.

There are arguments for taking short histories that simply direct the examiner to the sites that need forensic sampling and enable the provision of proper medical care and prophylactic medications. These types of histories will rarely provide fodder for Defense counsel who wish to highlight inconsistencies in a complainant's history. They also fit nicely within those judicial systems that do not seek to elicit the best history, but simply one version of events. There are converse arguments for taking more in-depth histories. These can be richer in detail, might provide information that suggest further forensic evidence collection possibilities and are often more useful for those who are seeking to defend themselves against false allegations. Whichever style you use, there will be strengths and weaknesses associated with the approach. It is useful for examiners to be aware of these.

Some examiners choose to use disclaimers, in statements to police, elucidating the purpose of the sexual assault history collected by the forensic examiner. The history might have been taken to direct the examination. It might not be a full or detailed record of events. The history given by the complainant to the examiner will probably not appear in its entirety in any subsequent statement. Most examiners will remove extraneous information not thought relevant for the case at hand. Of course, without all the facts pertaining to the case, it can sometimes be difficult to assume what may or may not be relevant. For this reason it is important to keep all contemporaneous notes.

Clarify all colloquial statements. Do not assume that you understand what the complainant means. Use quotation marks when directly quoting the patient.

Most sexual assault units will record relevant post assault activity conducted by the complainant, after the assault and prior to examination. Activities such as changing clothes, bathing, swimming, douching, urinating, defaecating, vomiting, drinking, eating, cleaning teeth can all impact, to varying degrees, the retention of offender DNA on the body of the complainant.

All complainants should be asked about alcohol consumption in the preceding 24 h, drug consumption (illicit, over the counter and prescribed) in the preceding 3–5 days, and if there is any suspicion that a drug was given to them without their consent or knowledge. Complainants who have urine collected for toxicological assessment should understand that drugs taken weeks previously (especially if a heavy or regular user) may also show up in analysis. In many jurisdictions, police are not interested and will not prosecute complainants who have illicit drugs in their system found in this way. An examiner should be aware of local police practices and advise complainants accordingly, prior to offering the collection of either blood or urine samples.

Forensic examiners should not ask suspects about the alleged incident.

Substance Use

Drugs and alcohol are covered in Chap. 12.

A forensic examiner should make every effort to have the results of toxicology analysis returned to them. These results can then be reviewed in conjunction with the clinical presentation of the complainant/suspect at time of forensic examination. This is one of the few methods for an examiner to improve future assessments and increase their clinical experience with drugs and alcohol.

Injury Documentation

Part of any forensic assessment, for sexual assault, is the documentation of injury. As complainants may not be aware of all injuries that have been sustained as part of an assault, it is important to include a full body review to ensure no injury is overlooked.

Injuries can be documented in three ways: in writing (verbally), by drawing them on a diagram and by imaging them (photograph or video). High quality documentation requires all three.

When measuring an injury the examiner should always keep in mind any risk of contamination. Give consideration to the type of scale used e.g. DNA free, sterile, single use or reusable and take steps to reduce any risk of DNA contamination, as required. A good rule of thumb is to collect any forensic biological evidence from the body of the complainant prior to documenting the injury or imaging it.

It is good practice to ask the patient, for every injury observed, whether they know how the injury occurred. If they are unaware how the injury occurred, you might ask whether they had noted the injury prior to the assault. It is not a good idea to record, for example, a linear scar at the bottom of the abdomen as a "Caesarean scar" unless you have actually seen the medical notes confirming this. When recording a patient's response you might record that the injury was "stated to have occurred as a result of having been punched to the eye" or "stated to have occurred as the result of a fall in childhood" etc. Alternatively, you might directly quote the patient, "That happened when I fell onto the coffee table when I was six." This enables you to confirm in Court, if asked, that it was the patient who told you that the injury occurred in this manner.

Occasionally, there may be factors that impinge on the quality of your examination. These should be noted. They may include:

- Seeing a patient in an unusual site e.g. in a bed in a ward rather than in a dedicated forensic examination suite
- Poor lighting
- Multiple interruptions
- The complainant's emotional status
- The actions of relatives/friends
- Use of a translator

Whether a forensic examiner documents non-medical findings, such a tattoos or piercings, is a matter of personal preference. Sometimes a simple disclaimer acknowledging that tattoos or piercings were seen but not itemized, might be sufficient.

Whenever there is a clear account of the alleged incident, the anogenital examination can be tailored to the individual case (e.g. if an adult complainant only describes being made to perform fellatio, there is usually no indication to examine the external genitalia).

Be aware that a complainant may not always give an accurate account of the offence, for a variety of reasons. A New Zealand study in 1992 described 16 cases where penile vaginal penetration took place and the complainants denied ejaculation having occurred. Of the 16, seminal fluid was detected in 7, including 3 people who reported that a condom had been used [29].

Furthermore, children and some adults may not have the language skills or may feel unable to provide a detailed account of the sexual acts at the initial interview. In such cases, a comprehensive anogenital examination should be undertaken if the patient, or the person with legal authority to consent on behalf of the patient, gives his or her consent.

Physiology

Female Physiology

The female hypothalamic–pituitary–gonadal axis is developed at the time of birth. During the first 5 days of life, the level of gonadotrophin-releasing hormone (GnRH) rises, with a consequent transient rise in gonadal estrogen, attributable to the withdrawal of placental estrogen [30]. The estrogen causes prominence of the labia and clitoris and thickening and redundancy of the hymen. The neonatal vagina is purported to measure 4 cm in length [31]. Although after 3 months the GnRH levels gradually fall, the estrogenized appearance of the genitalia may persist for the first 2–4 years of life [32, 33]. During this period, the external genitalia gradually becomes less prominent; eventually, the hymen becomes thin and translucent and the tissues appear atrophic; occasionally, the hymen remains thick and fimbriated throughout childhood. The non-estrogenized vagina has relatively few rugae and lengthens by only 0.5–1.0 cm in early childhood [30, 31].

The hypothalamic–pituitary–gonadal axis is reactivated in late childhood, and the breasts and external genitalia alter accordingly. These changes are classically described in terms of their Tanner stage [34]. Under the influence of estrogens, the vagina lengthens to 7.0–8.5 cm in late childhood, eventually reaching its adult length of 10–12 cm [30, 31].

The estrogenized vagina is moist because of physiological secretions. This endogenous lubrication is enhanced with ovulation and with sexual stimulation [35]. The endogenous estrogen levels fall at the time of the menopause and as a consequence of this the vulva and vagina atrophy.

In times past, the physiology of the human sexual response was not particularly well understood. It had been assumed that injury during non-consensual intercourse was likely to occur more frequently than during consensual intercourse because of several factors, one of which was the lack of vaginal lubrication of the complainant (who was not wanting intercourse).

Mr. Scott Volkers was the head coach of the Australian women's swimming team when 3 swimmers, aged between 12 and 14 years, disclosed sexual abuse during their time under his care. It went to a committal hearing in 2002 and advice had been sought by the then-deputy director of the NSW Department of Public Prosecutions. The Deputy-Director gave advice that girls this age were unlikely to have fully developed breasts and hence allegations of groping (of the breasts) would be difficult to prove. One girl gave evidence of Mr. Volkers having rubbed her vagina through a pair of shorts and a swimming costume, resulting in an orgasm. The deputy director found this difficult to believe stating that it would be hard to accept that the girl could have been sufficiently relaxed for orgasm to occur. These were amongst the reasons for charges being dropped against him. Mr. Volkers was eventually re-arrested and charged with multiple child sex offences in 2017 [36].

Levin and van Berlo (2004) examined whether non-consensual sexual stimulation could lead to unwanted sexual arousal [37]. They opined that arousal was both a mental state and a physical state. They could occur independent and without the other, they could occur either before or after the other.

Physical changes that might occur in a woman who is aroused sexually include:

- Increased heart rate, blood pressure and respiration
- Increased blood flow to the breasts, nipple erection
- Clitoral engorgement of blood
- Increased vaginal lubrication
- Irregular contractions of pelvic muscles around the vagina
- Orgasm

In other words, arousal can occur even in the absence of consent.

Male Physiology

Semen is not produced until the male reaches puberty, which usually begins between 9 and 14 years of age [38]. Semen consists of seminal fluid (produced by the prostate) and spermatozoa. The normal volume of a single ejaculate is between 2 and 7 mL, and it will contain approximately 50–120 million spermatozoa per milliliter. There are numerous congenital and acquired causes for impaired spermatogenesis [39], resulting in either decreased numbers (oligospermia) or absence of (azoospermia) spermatozoa. Both conditions may be permanent or transitory depending on the underlying cause.

Forensic practitioners may be asked to comment on a person's ability to achieve a penile erection, particularly if the male is young or elderly. Masters and Johnson [40] note that during their research, "penile erection has been observed in males of all ages ranging from baby boys immediately after delivery to men in their late eighties"; they report that one 89-year-old study subject was able to achieve a full penile erection and ejaculate. Therefore, it is not possible to reach a conclusion regarding erectile efficiency based on age alone. When a defendant reports erectile dysfunction, the expert opinion of a urologist should be sought.

Penile erection may result from visual stimulation (including fantasy) or tactile stimulation. The penis, scrotum, and rectum are all sensitive to tactile stimulation [40], which may explain why involuntary penile erections can be experienced by males subjected to nonconsensual anal intercourse.

Physical changes that might occur in a man include:

- Increased heart rate, blood pressure and respiration
- Nipple erection
- Penis engorgement of blood
- Elevation of testicles
- Rhythmic contractions of pelvic muscles
- Orgasm
- Ejection of seminal fluid [37]

Levin and Berlo's conclusion was that, despite a limited amount of published literature, case and anecdotal reports suggest that the induction of arousal and even orgasm does not permit the conclusion that the subjects consented to the stimulation. "A perpetrator's defense against the alleged assault built solely on the evidence that genital arousal or orgasm in the victim proves consent has no intrinsic validity and should be disregarded" [37].

Anatomy

Female Genital Anatomy

The external female genitalia (vulva) includes the mons pubis, the labia majora, the labia minora, the clitoris, and the vestibule (which incorporates the openings of the urethra and the vagina).

The labia majora are the outer vaginal lips with skin on the external surface and mucosa internally. The labia minora are the inner vaginal lips and these are covered with mucosa. The posterior fourchette is the junction of both lower aspects of the labia minora. The fossa navicularis is the mucosal depression between the posterior fourchette and the vaginal wall/hymen/hymenal remnants. The anatomical vagina is a muscular canal that begins at the hymen and extends to the cervix. The hymen is the tissue that partially or completely surrounds the opening of the vagina.

All sexual assault examiners should confidently be able to identify these landmarks as they are often the site of injury in both consensual and non-consensual intercourse.

The skin of the labia majora and the outer aspects of the labia minora is keratinized squamous epithelium, but only the outer aspects of the labia majora are hair bearing. The inner aspects of the labia minora and the vestibule (including the hymen) is nonkeratinized. This area is usually pink but, in the non-estrogenized child, it may appear red because the skin is thinner and consequently the blood vessels beneath its surface are more apparent [31].

The vagina and cervix are covered by nonkeratinized squamous epithelium that normally appears pink in the estrogenized female. Occasionally, the columnar endocervical epithelium, which appears red, may be visible around the cervical os because of physiological or iatrogenic (e.g., exogenous estrogens) eversion of the endocervical canal; these are sometimes erroneously referred to as cervical erosions. The perineum is the area between the posterior fourchette and the perianal area (in a female). The perineal body is the central tendon located between the vestibule and the anus. It can occasionally be pigmented or white and is known as the median raphe [41].

Peri-urethral and peri-hymenal bands are small bands of tissue connecting two opposing surfaces, with the same colour and texture as the surrounding tissue [42].

Ano-rectal Anatomy

Most forensic examiners experience some difficulty with interpretation of anal and perianal injury. An understanding of the anatomy is a useful basis for considering issues that might be raised in relation to forensic injuries.

The rectum extends from the anal transitionary zone to the sigmoid colon and is 8–15 cm long. It is lined by typical intestinal mucosa and is red in the living. The rectum has only poorly defined dull sensation [43].

The anus is essentially divided into three sections. The uppermost section is called the proximal anus. This is a transition zone where the cells change from rectal cells to anal cells. It is usually located in the region of the anal columns and is purple [44].

The proximal anus is separated from the middle (or intermediate) zone by the pectinate (dentate) line. The middle zone is lined by cells called anoderm. The anal canal is lined by nonkeratinized squamous epithelium and is salmon pink in the living [45]. It is sensitive to touch, pain, heat, and cold to just above the dentate line [43].

The distal zone (closest to the exterior of the body) is lined by the same cells but has hair and sebaceous glands within it. The division between the middle and distal zone is called the anal verge and marks the point where anoderm becomes true skin. This is a histological demarcation, although occasionally it can be determined macroscopically.

The anal canal is narrow (in its non-distended state) measuring, on average, in adults (age range 18–90 years) 2.1 cm, with a range of 1.4–3.8 cm in males and 1.0–3.2 cm in females [46]. It is normally closed at one end by the internal and external anal sphincters.

The internal anal sphincter, smooth muscle under autonomic control, maintains approximately 80% of resting anal tone whereas the external sphincter, skeletal muscle, is responsible for the remainder. It has some voluntary control. This internal sphincter is a continuation of the circular muscle coat of the rectum and extends 8–12 mm below the dentate line.

This external sphincter encircles the internal sphincter but extends below it, ending subcutaneously. The lower edges of the external and internal sphincters can be distinguished on digital palpation. Although this sphincter is tonically contracted in the resting state, this contraction can be overcome with firm pressure [44]. If the patient is asked to contract the anus during a digital assessment, the external sphincter can be felt to ensure contraction and closing of the anus tightly. However, because the muscle fibers are predominantly the slow-twitch type, a maximum contraction of the external sphincter can only be maintained for approximately 1 min [47].

Because the anal canal can evert and invert as the anal sphincters and pelvic floor muscles relax and contract, the anal verge/margin is not a fixed, identifiable landmark.

The anus and lumen of the anal canal usually appear as an asymmetric Y-shaped slit when viewed via a proctoscope (anoscope). The folds of mucosa and subcutaneous tissue (containing small convoluted blood vessels surrounded by connective tissue) between the indentations of the Y are referred to as the anal cushions. Although this appearance is usually obscured externally by the folds of skin on the perianal area, it may become apparent if the patient is anesthetized or as the anus dilates.

Distension of the rectum is the stimulus for the involuntary relaxation of the internal sphincter, inducing the desire to defaecate. This allows some stool or flatus into the upper anal canal for sampling and identification [48]. If appropriate, volitional Valsalva straining begins, leading to an increased intra-abdominal pressure, pelvic descent and the overcoming of the recto-anal inhibition reflex.

Manometry testing shows that the anal resting pressure is never zero in healthy individuals. It can decrease with age, some diseases and as a result of certain trauma [48]. It is unlikely then that semen deposited in the vagina or near the anus makes its way passively into the anal canal unless there was either some damage to the anal canal (as evidenced by incontinence) or had been moved there via secondary transfer. Secondary transfer can occur in many ways including wiping the area after toileting or iatrogenic contamination i.e. an examiner has contacted the swab with the outer perianal area in the process of inserting the swab.

The diastasis ani should not be confused with scarring or injury. It is a congenital midline depression which may appear in some people, either anterior or posterior to the anus. It marks a congenital absence of the superficial division of the corrugator ani muscle. It may be V-shaped or wedge shaped.

Adolescent Anatomy

Curtis and San Lazaro (1999)[49] stated that it had been their experience, in examining more than 1000 sexually active adolescents, the most common appearance of the hymen was of indeterminate disruption to the free edge. Complete clefting or significant gaps in hymeneal rim was thought to be unusual [50]. Very little is really known, however, about normal female adolescent genitalia and much is anecdotal, or studied without the use of magnification or photographically documented [51].

In Emans et al. study of 100 sexually active adolescent girls 21% were found to have myrtiform caruncles, defined as rounded bumps of hymen separated on both sides by a complete cleft. Interestingly, there is very little literature about myrtiform caruncles. Emans et al. failed to find myrtiform caruncles in 200 sexually inactive post menarchal girls [52].

Reliable information about the appearance of the adolescent/adult hymen remains scarce. This is not surprising, given the infrequency with which it is reviewed. A survey of 126 consultants (predominantly pediatricians and gynecologists) in 1997 found that 91 examined the genitalia of adolescents less than 5 times a year. Only 28 out of 75 assessed the hymen when doing a genital examination [50].

Pre-pubertal Anatomy

Hymen

Kinsey wrote: "I think any creator who claims that he had a purpose in creating the hymen certainly shows himself incapable of having done a good job" [53].

Interest in the human hymen has been predominantly cultural and spiritual. Medical interest, especially forensic, is relatively new. As late as 1987, a survey of 129 physicians, primarily pediatricians and family practitioners, asked to label anatomic parts on a picture of the genitalia of a young girl, showed that only 59% correctly identified the hymen [54].

Perhaps the simplest explanation for this anatomical chasm is that the genital examination is not a routine part of medical assessments in pre-pubertal girls. To date there is a dearth of longitudinal studies detailing normal hymeneal anatomy in any age group and none have been performed that follow girls aged over 9 years.

The hymen is a membrane which partially, or rarely completely, covers the external vaginal orifice. It is located at the junction of the vestibular floor and the vaginal canal.

The hymeneal membrane is of endodermal origin and consists of fibrous connective tissue attached to the vaginal wall (partly elastic and partly collagenous). It is comprised of squamous, stratified epithelium. The hymen is not richly supplied with nerve fibers. The vascular supply is rich in the lower border but scarce close to the edges. The amount of elastic fibers (and the ability of the hymen to stretch) is highly variable [55], dependent upon both age and hormonal status. Nowhere is this demonstrated more eloquently than in the case report of a 21 year old woman who was found to possess a micro-perforate hymen (an opening in the hymen, 2 mm in diameter) in the 27th gestational week of pregnancy. Her hymen was relatively elastic, and penile penetration was possible without damage or causing the patient discomfort. It was also easily stretched by the examiner's fingers, reverting back to its original shape afterwards [56]. How the histology alters with advancing years has yet to be documented.

Perhaps the greatest mystery of the hymen relates to its function. According to many sources, human females are the only species to possess a hymen but hymens have, in fact, been reported in African elephants [57], dogs and horses. The anatomy of these animals differs significantly from that of their human counterpart by way of retention of an uro-genital canal, where both the urethra and uterine body terminate. In domestic animals the hymen disappears during the fetal period or after birth, except in the rare case of persistence of an imperforate hymen [58].

In human fetuses, the lumen of the vagina also remains separated from the cavity of the uro-genital sinus by the hymen but, unlike the animal model, it ruptures during the perinatal period and remains as a membrane around the entrance to the vagina, and is penetrated by the act of intercourse [59].

Hypotheses for the persistence of the hymeneal membrane have included:

1. Evolutionary predominance in societies where virginity of wives was demanded
2. A protection mechanism dating back to an aquatic past with the hymen evolving to protect the vagina from marine "pollution"
3. A structure designed to increase the retention of sperm and hence raise fertilization success and
4. An embryological remnant designed to keep the surrounding area protected from fecal and other material

The hymen has proved a fascinating piece of human anatomy if only by virtue of the fact that:

"This delicate membrane has no known physiological function, but its psychological and cultural significance as a sign of virginity has been enormous" [59].

Tanner Staging of the Hymen

In 1992 Tanner staging of the hymen was attempted for the first time. Patients in this study ranged from Tanner Stage 1 to 5 based on hymen development [60].

Tanner staging of the hymen seems to be rarely attempted in current practice, however.

Tanner Stage One	Hymen has very thin rim. Fossa navicularis characterized by a network of fine blood vessels extending to the edge of the hymeneal rim.
Tanner Stage Two	Thin hymeneal rims with less dramatic vascular patterns. Reduction in superficial vascular prominence noted at the hymeneal rim, fossa navicularis, and vestibule.
Tanner Stage Three	Hymen thicker with beginnings of redundant folds; although slight vascularity seen in some patients, previous widespread superficial vascular network generally absent; close inspection revealed first evidence of clear vaginal secretions. This stage thought to reflect beginnings of true estrogen effect.
Tanner Stage Four	Hymens dominated by thick projections and redundant folds. Neither hymen nor vestibule had visible blood vessels.
Tanner Stage Five	Morphologic qualities of Tanner stage 4 patients' hymens expressed to a greater degree by Tanner stage five patients.

Pediatric Hymeneal Morphology

There have been 3 longitudinal studies of the developing hymen, ranging from birth to 9 years of age. A summary of the morphology at each age group is summarized below. In the final study the author has added 2 new categories (folded, micro perforate) and removed 2 (fimbriated, sleeve like/ventral). It is not known whether the new terminology was chosen to replace the old or whether these were, in fact, new categories of their own [61–63]. Annular is the predominant morphology at birth being steadily replaced, with age, by crescentic.

Age	Annular	Crescentic	Fimbriated	Sleeve like/Ventral	Septated	Folded	Micro-perforate/Small orifice	Reference
Birth	70%	0%	21%	7%	2%			[62]
1 year	54%	28%	7%	11%	0%			[62]
1 year	52%	29%	10%	10%	0%			[61]
3 years	41%	50%	2%	7%	0%			[61]
3 years	39%	61%			1%	1%	2%	[63]
5 years	23%	77%			1%	0%	2%	[63]
7 years	18%	82%			1%	0%	3%	[63]
9 years	10%	90%			0%	0%	3%	[63]

Importantly, no study has ever documented a newborn without a hymen [61, 62, 64] and hymeneal tissue appears redundant in all neonates.

Clearly, morphology of the hymen is not constant. Berenson, for the first time, demonstrated changes seen over time [62]. In this study, 4 different hymenal types were observed in newborns: Annular (n = 40/57; 70.2%); Fimbriated (n = 12/57; 21.1%); Ventral (n = 4/57; 7%) and Septate (n = 1/57; 1.8%). None of the children in this study were noted to have had a crescentic hymen at birth.

At age 1 year it was noted that of those who had been observed to have an annular hymen at birth, only 62.5% had the same morphology 12 months later. 32.5% had changed to a crescentic hymen and 5% had a ventral hymen.

Of those who had been born with a fimbriated hymen, only 33% remain fimbriated at 1 year, 41.7% became annular and 25% became crescentic. All ventral hymens noted at birth remained ventral hymens at 1 year. The single septate hymen had converted to an annular hymen (i.e. lost the septum).

External Ridge

Definition: A midline, longitudinal ridge of tissue on the external surface of the hymen usually anterior or posterior, extending to the edge of the hymen.

The frequency of external ridges decreases with age. They become infrequent after 4 years of age and are unlikely to form de novo [65]. Berenson's results with regard to the presence and location of external ridges, from 2 studies, are summarized below:

	0 years	1 year	3 years
[62]			
6 o'clock position	45	5	
12 o'clock position	7	2	
[61]			
6 o'clock position	106		8
12 o'clock position	12		1

Intravaginal Longitudinal Ridges (ILR)

Definition: Narrow, mucosa-covered ridges of tissue on the vaginal wall that may be attached to the inner surface of the hymen.

ILRs that extended to the hymeneal rim have been observed with almost the same frequency at birth and at 1 year of age [62].

In a review of the genital anatomy of preschool children (1 month – 6 years of age) ILRs appeared in 25%, one child having up to five appearing evenly around the rim [65].

Tags

Definition: An elongated projection of tissue arising from any location on the hymeneal rim.

Tags can appear or disappear. They are not an uncommon finding at birth, the majority of which will disappear by 3 years of age. New tags, in this time period, appear to result from the extension of an intravaginal or external ridge beyond the rim or from fimbriated hymens that were noted to have had similar protrusions at birth. They can also form as the result of the disruption of a hymeneal septum [61].

Bumps

Definition: A solid, localized, rounded and thickened area of tissue on the edge of the hymen [66]. They are generally thought to be a normal variant.

Bumps were noted to originate from longitudinal intravaginal ridges, from external ridges and can occur independently of ridges [65].

Notches

Definition: A cleft or notch is an indentation in the rim of the hymen.

A deep notch (cleft) is defined as a V shaped defect extending through more than 50% of the width of the hymen [51] and a superficial notch (cleft) is one that extends through less than 50%.

A study of the hymens of 468 newborn girls [67] found that notches were a frequent anatomical variation and were found in 35% of the neonates with annular hymens [65].

Notches were observed significantly less often at 3 years than near birth. One reason for this is the evolution of most annular hymens with superior notches at birth into crescentic hymens. It has been noted that the majority of lateral notches at birth resolved by 3 years of age [61].

Superficial notches have been noted in the anterior and posterior rim of the hymen in the non-abused pre-pubertal population. Deep notches in the posterior half of a non-fimbriated hymen have only been reported in pre-pubertal girls with a history of vaginal penetration [68]. Joyce Adams et al., however, have relegated the deep notch to the category of findings where there is no expert consensus regarding degree of significance stating that a notch or cleft, at or below the 3 or 9 o'clock location, which extends nearly to the base is a "very rare finding" that should be interpreted "with caution" unless an acute injury was documented at the same location [69].

Further confounding this problem is the fact that notches may be dependent upon examination position. A study of 93 pre-pubertal girls (ages 10 months to 10 years) found more clefts when a traction method was used (6.6%) than when the separation (4.1%) or knee chest methods (2.2%) were used [42].

The interest in the posterior edge of the hymen is heightened by the finding that injury from sexual trauma predominantly occurs in this region, between five and seven o'clock [51, 64]. The mechanism for rupture is thought to occur as a result of the symphysis pubis preventing any anterior movement, forcing the penis posteriorly, causing trauma at the midline position to the posterior fourchette. Conversely, it has been suggested that in digital penetration, in children, the force is more likely to be directed to the sides rather than the midline [64].

In summary, notches may be congenital, arise de novo or disappear. They are seen at all ages. Partial tears of the hymeneal rim may resolve with the formation of a notch but not all notches are the result of injury, superficial notches having been documented in normal studies around the entire rim, although less common in the lower half.

Transections

Definition: An acute tear or laceration through the entire width of the hymeneal membrane extending from its edge to the vaginal wall attachment. Transections to the hymen suggest a prior penetrative event. Straddle accidents (without penetration) have not been known to cause acute hymenal injury.

Findings Caused by Trauma

Any examiner who will be conducting pediatric sexual assault examinations should be familiar with all the normal variants of anatomy in both sexes. Despite the number of variations possible there are only a few hard and fast signs of trauma. These include:

- Acute lacerations to any part of the genital anatomy
- Bruising, petechiae or abrasions to the hymen
- Perianal, Posterior Fourchette, Fossa Navicularis scars ("A very rare finding that is difficult to diagnose unless an acute injury was previously documented at the same location")
- Complete cleft below the 3 to 9 o'clock location that extends to the base with no discernible hymenal tissue at the location
- Signs of Female Genital Mutilation (FGM) cutting e.g. loss of part or all of the clitoris, clitoral hood, labia minora or majora [69]

Findings Diagnostic of Sexual Contact

- Pregnancy
- Semen identified from forensic swabs (taken directly from the child's body) [69]

Male Genital Anatomy

The male penis can be subdivided into the glans (head of the penis), coronal sulcus (neck) and shaft. There may or may not be a foreskin (prepuce). On the under surface of the penis there is a frenulum. There is generally two testicles contained within a scrotal sac.

During examination of the male genitalia, the forensic practitioner is expected to document any features that could assist with subsequent identification of the suspect, to note any acquired or congenital conditions that could make an alleged sexual act impossible, to describe in detail any injuries that could relate to a sexual act, and to retrieve any forensic evidence. Although the specifics of the medicolegal assessment of the male genitalia are case dependent, the principles of the examination, whether of the complainant or of the defendant, are the same.

Forensic practitioners may be asked to provide evidence on the size of a defendant's penis in the flaccid state to support a hypothesis that a certain sexual act could not have occurred because of inter-genital disproportion between the complainant and the defendant. However, such measurements are unhelpful because it is not possible to predict the maximum erectile size from the flaccid length, and there is “no statistical support for the ‘phallic fallacy’ that the larger penis increases in size with full erection to a significantly greater degree than does the smaller penis” [40]. Furthermore, even when the erect penis is measured during auto-manipulation or active coitus, the measurements are recognized to be unreliable [40].

Forensic Examination

Examination of Adolescents

The Foley catheter technique, referenced by Carol Jenny MD in 1992, is used primarily to view post-menarchal hymens and requires the insertion of an indwelling catheter midway into the vaginal vault with inflation of the balloon with 40–50 mL of air (this can be modified dependent upon patient comfort and examiner requirement). The balloon is guided outwards to the hymen edge, allowing the hymen to drape over the balloon so that the hymenal edges can be readily visualized [70].

Jones et al. used the Foley catheter technique to examine the hymen of 20 adolescents aged 13–16 years. Use of the Foley catheter balloon technique was virtually painless and allowed identification of more hymenal abnormalities than labial traction alone. The results are summarized in the table below [71].

	Labial Traction Only	Foley Catheter Method
Laceration	2	7
Abrasion	0	3
Ecchymosis	1	4

Alternate methods for examination of the hymenal edge include the use of a swab. The swab is run around the internal edge of the hymen so that all edges can be adequately visualized. Occasionally, normal saline can be used in an attempt to “float” the hymen, separating the edges to better view the hymeneal rim.

Examination of Pre-pubertal Girls

Currently there are two positions that are used for the examination of pre-pubertal girls.

The supine separation technique conducted in the frog leg position (patient on their back, knees bent and flopped outwards) and the knee-chest approach (patient on knees, facing away from examiner, with chest to table and bottom in the air). The latter moves the perineal body and posterior fourchette dorsally, exposing the introitus, and the anterior two thirds of the vaginal canal can often be visualized. It can aid in opening the hymeneal orifice [72]. This latter method is primarily used to support or counter abnormal findings found in the supine frog leg position.

Hymeneal Measurements

Until as late as 1995 it was suggested that a hymeneal opening diameter could be used to determine (or support) a history of sexual abuse. It had been suggested that hymenal openings more than 4mm, in the pre-pubertal child, were associated with sexual abuse [73, 74].

Both specificity and sensitivity of this finding has since been questioned.

Berenson found that approximately one third of abused pre-pubertal children had a horizontal measurement of greater than 6.5 mm in the knee-chest position, whereas two thirds of abused children did not (a specificity of 86% but a sensitivity of only 29%). When the child was examined in the supine position, horizontal hymeneal diameters of greater than 6.5 mm were noted to have a specificity of 73% but a sensitivity of only 32%. They opined that the specificity and sensitivity were not sufficient to warrant its use in either confirming abuse in those who provided a history of such or detecting undisclosed abuse [75].

Berenson also demonstrated that less than 1.0 mm of hymeneal tissue at 6 o'clock had a specificity and a positive predictive value of sexual abuse of 100%. However, the sensitivity of this test was extremely low (1–2%) as almost all of the abused children had greater than or equal to 1 mm of tissue visualized at six o'clock in both the supine and knee-chest positions [75]. It has now been widely accepted that posterior hymenal width cannot be measured accurately and that there is insufficient evidence to determine the significance of a "narrow" posterior hymeneal width in pre-pubertal girls [76].

Lateral measurements of less than 1 mm were observed in the supine position at both 3 o'clock and 9 o'clock and at three o'clock in the knee chest position among abused and non-abused children [75].

It has been suggested that instead of worrying about measurements, more attention should be paid to finding a clear rim of posterior hymeneal tissue (supine position), and a free hymeneal edge from the nine o'clock to three o'clock positions, as this is likely to represent a normal finding [77].

Injury

Female Genitalia Injury

Whether there is injury after vaginal penetration can depend on the presence or absence of a number of variables including, but not limited to, the amount of force used, level of "enthusiasm" of the participants, period over which the penetration continues, the size of the penis (or object), use of or presence of lubrication, associated drug or alcohol use, angle of penetration, experience of the participants, use of objects/toys, extremes of age (e.g. the very young and the old) etc.

Lacerations and ruptures (full-thickness lacerations) of the vagina have also been described in the medical literature after consensual sexual acts [78–80]. They are most commonly located in the right fornix or extending across the posterior fornix; this configuration is attributed to the normal vaginal asymmetry whereby the cervix lies toward the left fornix, causing the penis to enter the right fornix during vaginal penetration [80]. Factors that predispose to such injuries include previous vaginal surgery, pregnancy, and the puerperium, post-menopause, intoxication of the female, first act of sexual intercourse, and congenital genital abnormalities (e.g. septate vagina) [78]. Although most vaginal lacerations are associated with penile penetration, they have also been documented after brachiovaginal intercourse (fisting) [80], vaginal instrumentation during the process of a medical assessment [81], and the use of plastic tampon inserters [82]. Vaginal lacerations have been documented without any direct intravaginal trauma after a fall or a sudden increase of intra-abdominal pressure (e.g., lifting a heavy object) [80].

Healing of lacerations of the external genitalia is predominantly by first intention, with no residual scarring being detected at follow-up assessments [83, 84]. Nonetheless, scarring may occur occasionally in these areas, but it is important not to mistake a linear vestibularis, a congenital white line identified in the fossa navicularis (present in 25% of neonates), for a scar [85].

When a vaginal laceration may have been caused by an object that has the potential to fragment or splinter, a careful search should be made for foreign bodies in the wound [78] (this may necessitate a general anesthetic), and X-rays should be taken of the pelvis (anteroposterior and lateral), including the vagina, to help localize foreign particles [86]. Any retrieved foreign bodies should be appropriately packaged and submitted for forensic analysis.

Consensual V Non-consensual Injuries

The issue of determining the likelihood, or otherwise, of consent having been given based on the injury found has been studied extensively.

In 2003 Jones et al. concluded, after reviewing ano-genital injuries in adolescents after consensual intercourse, “clearly, the presence of ano-genital trauma suggests that penetration has occurred and implies nothing about consent” [87].

In 2006 Anderson et al. opined that “Currently many experts and laypersons alike believe that if women do not consent to intercourse, they are more likely to have injuries to their genital area. Based on the findings of this study and several other studies, there is evidence to suggest that injuries can be identified on examination after both non-consensual and consensual intercourse” [88].

Lincoln et al., in a 2013 journal paper, compared two groups of women. One group had sexual intercourse with consent and one group were complainants of sexual assault. It was noted that, of the 8 women in the study who had vaginal penetration with fingers only (and all were sexual assault complainants), 6 had observable injuries. Their opinion was that “Penetration exclusively with finger/s was more likely than any other scenario to result in an injury [Odds Ratio 11.25, $p<0.005$]” [89].

Dr. M. O’Keefe in 2008 perhaps best summarizes the current thought on the matter:

“On the basis of current research, it has not been found possible to identify clinical signs which might reliably distinguish non-consensual from consensual sexual intercourse” [90].

It should also be recognized that not only can consensual intercourse result in injury but it can also result in significant injury.

Ahmed et al. reviewed patients admitted to a surgical and gynecological unit over a 7-year period. There was 1 labial, 9 posterior fourchette and 16 vaginal wall lacerations following consensual intercourse that required suturing [91].

Frioux et al. presented a case series of four female adolescent patients over a period of 6 months, each of which had developed significant vaginal bleeding after intercourse, 3 of which presented to the Emergency Department with vital signs consistent with compensated shock. Three of them described consensual intercourse prior to the injury (presenting with lacerations in the fornix, at the top of the vaginal vault) and one described the injury occurring during a sexual assault (presenting with vaginal wall laceration) [92].

Jones and O'Connor reviewed presentations to the Royal Brisbane (Australia) between 2007 and 2011. Vulval non-obstetric trauma was found in 19 of 519 cases. Injuries were due to, amongst other things, consensual (n = 7) and non-consensual (n = 3) intercourse. The seven post-consensual injuries comprised of a 7 cm labia minora tear, a 4 cm labia minora tear (requiring six sutures), a 2 cm labial minora tear, a 1.5 cm posterior fourchette tear, a 4 cm labia minora tear (requiring seven sutures), an unspecified size labia minora tear (requiring four sutures) and a 4 cm mid-labial sulcus tear and bruise [93].

Fisting

Cappelletti et al. [94] did a systematic review of fisting (brachiovaginal or brachioproctic insertion) in the forensic literature in 2016. They identified it as a "potentially dangerous sexual practice". When it involves insertion into the anus the fist may continue past the upper rectum, reaching the sigmoid colon or, less commonly, the descending colon.

The fourteen studies they selected had case numbers ranging from 1 to 11 people. They were able to determine consent status in 27 cases (consensual in 18/non-consensual in 9). Vaginal fisting is represented far less commonly than anal fisting. There was only 1 vaginal fisting case out of the 18 consensual and 3 of the 9 non-consensual cases studied. Two of the non-consensual cases involved fisting of both the vagina and the anus. Of the 18 consensual cases, 2 ended in death.

Of all the cases studied, eight were fatal.

Internal injuries of the rectum generally originated above the dentate line and extended to between 6 and 18 cm beyond the anal verge. When vaginal injuries occurred they were generally lacerations of the posterior part of both the cervix and vagina [94].

First Sexual Intercourse

Nearly 30 years ago, 100 women were interviewed at random and asked about their first coital experience. Results are summarized in the table below [95]:

Incidence of Bleeding		Incidence of Pain	
No Bleeding	44	No Pain	32
Slight Bleeding	35	Slight Pain	22
Moderate Bleeding	9	Moderate Pain	15
Heavy Bleeding	12	Severe Pain	31

While this study has apparent limitations such as requiring memory of events in the past; inability to exclude other reasons for bleeding other than coitus; and the inclusion of seventeen women who reported some other kind of vaginal penetration prior to first coitus (e.g. examination by physician, tampons, douching, diaphragm, masturbation, foreplay with digital penetration) it eloquently debunks the myth that bleeding on the “wedding night” is confirmation of virginity [95].

Adolescent Injury

While no child has ever had a documented congenital transection [61], Emans et al. documented complete transections in 3% of 200 non sexually active post-menarchal girls, between the four and eight o'clock positions. This was attributed to undisclosed sexual abuse or prior sexual experience [96]. Adams et al. have since reproduced these findings, noting the same frequency of girls in the “no previous sexual intercourse” group with either a deep notch or transection. These girls had described painful insertion of a tampon [51].

Goodyear-Smith et al., after re-analysis of Emans’ data on tampon users versus pad users and the subsequent development of complete clefts, came to the conclusion, contrary to Emans, that there is a “definite possibility” that tampon use can be associated with an increased percentage of complete hymenal clefts [97].

Equally as interesting was the fact that 26% of the girls in the Emans study, who admitted past sexual intercourse, had no evidence of a complete cleft between the 3 and 9 o’clock position [96]. Likewise, another study of pregnant teenagers (definitive evidence of sexual contact) revealed genital changes in only 2 of 36 that were diagnostic of penetrating trauma [98]. In this study (at that time), findings that were interpreted as clear evidence of penetrating trauma included hymeneal transections / lacerations, laceration of the posterior fourchette, scar of the posterior fourchette associated with loss of hymeneal tissue between 5 and 7 o’clock as well as an absent hymen in the posterior half of the ring.

Pre-pubertal Injury

Heger et al. evaluated 2384 children for possible sexual abuse. A total of 96.3% of all children referred for evaluation had a normal medical examination. Only 4% of all children presented with medical findings diagnostic of abuse. These findings were primarily acute injuries, sexually transmitted diseases, positive forensics, or genital scarring (such as complete hymeneal transections) and included one child with an anal scar [99].

"Both the nature of the abuse and the process of disclosure impacts on the medical examination. Most children are not abused in a way to leave permanent physical findings. Children are usually abused by an individual known to them who wants continued access to them" [99].

The only conclusions that can be reached is that penetrative intercourse (through the hymen) is a rare occurrence in the pre-pubertal age group or that penetrative intercourse can occur, in some cases, without enduring symptoms or signs. It is possible that penetration more commonly occurs superficial to the hymen e.g. simulated intercourse. As yet unanswered is the role of grooming in preparing the pediatric vagina for penetration/sexual intercourse.

Sequelae of Transections

There are few papers that document the healing of ano-genital trauma in children. Heppenstall-Heger demonstrated that, of the 17 transections of the hymen that her team followed, 15 persisted (2 being repaired successfully at surgery), including the 6 followed to puberty [100].

Although there is anecdotal evidence to the contrary, there is no published study that disproves the notion that transections do not heal spontaneously, without residua, unless they are surgically repaired [100].

Male Genital Injury

After consensual sexual intercourse, lacerations of the foreskin and frenulum, meatitis, traumatic urethritis, penile edema, traumatic lymphangitis, paraphimosis, and penile "fractures" have all been described [101–104]. Accidental trauma is more common when there is a pre-existing abnormality, such as phimosis [101], or when the penis is erect. "Fracture" of the penis occurs when the erect penis is forcefully bent (or struck) rupturing the tunica albuginea of one or both corpora cavernosa. Patients sometimes hearing a cracking noise, loss of erection and pain [105].

Skin injury may be incurred if the genitals are deliberately bitten during fellatio [101]. Although the precise incidence of male genital trauma after sexual activity is unknown, anecdotal accounts suggest that it is rare to find any genital injuries when examining suspects of serious sexual assaults [106].

In children the genitalia may be accidentally or deliberately injured, and the latter may be associated with sexual abuse [107]. Bruises, abrasions, lacerations, swelling, and burns of the genitalia of prepubescent males have all been described [107, 108].

When obtaining the relevant forensic samples, the forensic practitioner should inspect the male genitalia with particular reference to the following points:

1. Congenital abnormalities, such as micro phallus and cryptorchidism. Penile length in the flaccid state is said to vary from 8.5 to 10.5 cm (measured from the anterior border of the symphysis along the dorsal surface to the distal tip of the penis), with a documented range of 6–14 cm [40].
2. Acquired abnormalities, such as circumcision, Peyronie's disease, balanitis xerotica obliterans, vasectomy scars, phimosis, tattoos, and piercing.
3. Signs of infection such as warts, discharge, erythema, and vesicles.

Foreign bodies may be worn around the base of the penis, sometimes also encircling the scrotum, in an attempt to increase and sustain penile tumescence. Such devices may result in local and distal genital trauma (penile tourniquet syndrome) [109]. In several case reports, children have had human hairs wrapped around the penis; these hairs may be virtually invisible because of edema or epithelialization [110]. Kerry and Chapman [111] have described the deliberate application of such a ligature by parents who were attempting to prevent enuresis.

Ano-rectal Injury

A lack of perianal or rectal injury does not mean that penetration did not take place or that the complainant consented to the sexual acts as it is generally accepted that with gradual dilatation and lubrication, consensual penile anal intercourse can be performed without any resultant injury [112, 113].

Tears (anal fissures and lacerations), abrasions, redness, and swelling of the "anus" have been described following consensual and nonconsensual acts [113–115]. However, the lack of detail regarding the nature of the consensual sexual acts makes it difficult to determine whether the findings were coincidental, i.e., due to nonsexual causes or directly related to a sexual act. For example, anal fissures may result from numerous other means that are unrelated to penetrative trauma, including passage of hard stools, diarrhea, inflammatory bowel disease, sexually transmitted diseases, and skin diseases [116, 117]. Bruises appear to be infrequent findings following consensual sexual acts. However, the lack of data on perianal injuries make it impossible to determine whether this is a significant observation.

Injury to the Mouth

If injury follows fellatio it is most commonly erythema of the palate, petechiae or purpura. Areas of petechial hemorrhage and confluent bruising have been described on the soft palate and at the junction between the hard and soft palates after consensual fellatio [118–120]. These areas of bruising vary from discrete single or bilateral lesions of 1.0–1.5 cm in diameter, located on or either side of the midline [119], to larger bands of bruising that cross the midline [118, 120]. The bruises are painless and resolve in 7–10 days [118, 119], although they may reappear with repeated fellatio [119]. The uvula is usually spared and the hard palate is infrequently involved [121].

A forensic practitioner may be asked to explain to the court why these bruises occur. Although the precise mechanism is unknown, the following hypotheses have been proffered:

- *Repeated contraction of the palatal muscles*: As the penis touches the palatal mucosa, the gag reflex is activated, with resultant contraction of the soft palate and other constrictor muscles of the pharynx. It is suggested that the combination of retching and repeated palatal movements causes rupture of the blood vessels in the highly vascular palatal mucosa [118].
- *Sucking*: Sucking on the penis produces a negative intraoral pressure, which is postulated to cause rupture of the blood vessels in the palatal mucosa. This theory is supported by the anecdotal accounts of oral surgeons who found petechial hemorrhages on the palates of children who “made a habit of forceful sucking into a drinking glass” [119].
- *Blunt trauma*: Case reports describe palatal bruises subsequent to sexual assaults wherein a digit or digits have been forced into the mouth [122]. There is no specific evidence to support the hypothesis that direct blunt trauma from a penis can cause palatal bruising, however.

Differential diagnosis of palatal petechiae and purpura include:

- Blood dyscrasias e.g. disseminated intravascular coagulation, hemophilia, idiopathic thrombocytopenic purpura, leukemia
- Paroxysm of violent coughing, sneezing or vomiting
- Suction (negative intra-oral pressure)
- Infections e.g. infectious mononucleosis, measles, streptococcal infections
- Medications e.g. anticoagulants
- Systemic illnesses e.g. Hereditary hemorrhagic telangiectasias, scurvy
- Trauma e.g. fellatio, intubation, nasogastric tube, chemical and thermal injury
- Tumors e.g. nasopharyngeal carcinoma [121]

Whenever a complaint of nonconsensual fellatio is made, the head and face must be carefully examined because there may be other injuries around the oral cavity that support the allegation, such as bruises on the face and neck or lacerations of the frenula [123].

Basic Principles of the Forensic Analysis

Purpose and Value of Forensic Collections

The purpose of forensic sample collections, in cases of alleged or suspected sexual assault, is two-fold. The first is to collect sufficient evidence that can provide the identity of the alleged suspect; the second is to support a claim that sexual penetration occurred. Penetrative events can include the penetration of the anus or vagina by a penis, finger/s, tongue or other object or the penetration of the mouth by a penis. The forensic laboratory can also identify potential links with other offences.

Neither of these provide any evidence as to the fundamental issue of whether or not valid consent was present.

The value of forensic sampling is difficult to measure. If DNA is not recovered from the body samples it does not necessarily preclude an assault from having occurred. As time progresses, the likelihood of positive profiling from these samples is reduced. If the identity of the suspect is known and a claim is made by the accused that intercourse was consensual, it is likely that other evidence might be required to support a prosecution. It is therefore important for complainants to understand that body sampling for evidence collection is only one piece in the evidence puzzle. Other evidence that might be collected, dependent upon the individual circumstances of a case, include CCTV (close circuit television), discarded tissues/condoms/sanitary items, clothing worn immediately after the event by both the complainant and suspect, witness statements, complainant statements, forensic evidence from the body of the suspect, text messages, social media postings, mobile phone records, computer records etc. This evidence collection requires police involvement. The earlier a police investigation begins, the less chance important evidence will be lost, degraded or otherwise compromised.

In a review of data [124] collected from 257 cases of alleged sexual assault between 2005 and 2011, with victims aged 12 years or older, only 16.3% of cases had the biological samples needed and had DNA from a potential suspect sufficient to enable checking for a match. 31.6% of the samples without a "DNA match to suspect" did not have evidence kits taken, 29.9% had kits taken but no biological evidence was derived from them, 8% had biological evidence but no DNA analysis (possibly because the quality of the evidence was not adequate for DNA testing), 3.4% had DNA analysis that did not yield a DNA profile, and 10.3% had a DNA profile with no suspect for comparison. A suspect sample was not obtained in 30.3% of cases with a DNA profile [124].

Prosecutors opined that the value of biological evidence was for the establishment that a sexual act occurred, identifying suspects in stranger cases or when the complainant's ability to identify the suspect was compromised, and for confirming the correct person was being prosecuted even if there was additional evidence linking the defendant to the complainant [124].

The primary defense was usually that intercourse was consensual, especially when the defendant and the complainant knew each other. Less commonly used was a challenge of the integrity of the process [124].

In 2017 the Federal Bureau of Investigation (FBI) expanded the number of unique DNA markers searched in CODIS (The Combined DNA Index System—US national database) from 13 to 20, dramatically increasing the power of forensic DNA testing [125]. It also increased the chance of contamination via secondary and tertiary transfer evidence. This has presumably led to another common defense i.e. providing alternate explanations for how the DNA of the defendant was found on the complainant or crime scene.

Cale et al. [126] suggested that individuals can have their DNA deposited on an item, in sufficient quantities, to be the only contributor or the major contributor without ever coming into contact with that object i.e. through secondary transfer. They defined secondary transfer as the transfer of DNA from one object (or person) to another via an intermediate object (or person). Tertiary transfer has been defined as the transfer of DNA from skin to object to vector to object. For example, person A touched object 1 and person B (the vector) touched object 1 and then touched object 2. It is tertiary transfer if DNA from person A is then found on object 2 [127]. In most cases, the number of indirect steps is unknown and so some prefer the term "indirect transfer" in preference to "secondary", "tertiary" etc. [20].

Indirect transfer should be a concern because it could falsely link someone to a crime, it could link extraneous DNA onto a forensic sample and it could lead to the false conclusion that DNA recovered from an object was a result of direct contact [126].

Preliminary work carried out by the Body Fluid Forum of the UK and Ireland [128] indicates that female DNA may sometimes transfer to the man's underpants following non-intimate social contact. In one experiment, vigorous contact took place between both parties' hands and between the male's hands and the female's face; the male went to the toilet and simulated urination. Subsequent analysis showed that in a small number of cases female DNA was transferred to the male's underpants [129].

Lowe et al. [130] conducted experiments which showed that caution should be exercised in interpretation of results where trace DNA is involved. The experiment involved two people, one a good DNA shedder and another a poor shedder holding hands for 1 min after which the poor shedder immediately held a plastic tube. In one case, only the good shedder on the tube was detected even though it was the poor shedder who touched the tube. No evidence of a mixed profile was observed. Therefore, the vector was not always the one with the most dominant profile on an object.

Kanokwongnuwat et al. [131] observed that males shed more DNA than females. They explained that the larger area of fingerprint left by a male might explain some of the difference. It was also observed that a thumb print, on average, generated more alleles than a print from the little finger. It now seems likely that people are rarely either a consistently good or consistently bad shedder. DNA shedding, on any particular day is likely to be due to a complexity of factors [132].

Illustrative Case *The murderer, dubbed the Phantom of Heilbronn, had baffled German investigators for 2 years. Police had DNA which linked a female assailant to 40 crimes including 6 homicides stretching into Germany, Austria and France. She was linked to the murder of a policewoman in Heilbronn, Germany. After police had accumulated over 16,000 h of overtime investigating the cases they discovered that the cotton swabs they had been using for evidence collection had been contaminated by the same worker at a factory in Austria and that the "Phantom of Heilbronn never existed". The swabs being used had been sterilised and double packaged. This highlights the point that sterilisation alone does not necessarily denature DNA and that caution should be taken when basing an investigation solely on DNA evidence* [133].

Guidelines for Evidence Collection from Complainants and Suspects

Body evidence collection guidelines should be, wherever possible, evidence based. This evidence can come from published research. As DNA analysis methods have changed considerably over the last 4 decades this should be kept in mind when analyzing any recommendations made in older research publications. DNA extraction methods and the equipment used for this can differ between laboratories and so the best evidence would originate from a collation of results from the local forensic laboratory. Unfortunately, most examiners are not given access to this information. The reasons for this are often multifactorial.

In a recent commentary by Tully [134], Forensic Science Regulator for England and Wales, it was observed that the provision of forensic science was currently a "complex landscape", fragmented across public and private sectors. Some police forces exercised considerable control over the number of samples that could be analyzed in sexual assault cases, making the interpretation of results potentially more difficult. The cuts to forensic science services that have occurred presented an "almost existential threat to the profession".

Siloing of responsibilities i.e. police are responsible for the history of the assault, forensic examiners are responsible for body evidence collection and forensic scientists are responsible for analyzing only a predetermined number of selected specimens is an approach that may result in a court presentation less likely to be challenged. It is likely, however, that it will also not represent the full facts in the case.

Persistence Versus Success

When looking at different evidence collection methods it is worth considering two factors. Persistence relates to the longest time period recorded in which a substance lasted or could be identified. This may relate to complete spermatozoa, enzymes such as amylase, alkaline phosphatase or prostate specific antigen, autosomal profiles from DNA, mitochondrial profiles from DNA (inherited through the maternal line), Y-STR profiles from DNA (inherited through the paternal line) etc. Success relates to the number of positive results from a given number of collection attempts. Both can be impacted by various things e.g. age of the complainant, time since intercourse and various post coital activities such as washing, eating and drinking. Up to 70% of swabs can be negative for semen. Results may be negative when evidence is collected from complainants who did not engage in a penetrative sexual assault (as may occur if there was no memory of an actual assault), where ejaculation did not occur (which would decrease the likelihood of DNA collection) or where there had been a significant lapse of time between assault and assessment. A negative swab therefore may not be a reflection of inefficient sampling.

Forensic examiners should be aware of any local guidelines for forensic sample collections. For example, in the U.K., the Faculty of Forensic and Legal Medicine [135] publishes and regularly updates Recommendations for the Collection of Forensic Specimens from Complainants and Suspects. The method chosen to collect various samples is likely to differ between sites and will often depend upon local laboratory capabilities to analyze those samples. The evidence underpinning current time periods for collection have been included in the section below. Cut off time periods in practice, however, should be determined regionally and an examiner should have a basic understanding of how those time limits were derived and the research data that underpins them. Guidelines should be reviewed regularly and should rely upon the experience of local forensic laboratories (statistically and not anecdotally) as well as published research.

If you are a new forensic examiner or an examiner with only an intermittent or small caseload there is value in taking a "cookie cutter" approach to forensic collections e.g. if there is an allegation of penile vaginal penetration, guidelines might suggest that you collect vulval, low vaginal and high vaginal samples. If you are an examiner who works at an established unit with a generous caseload experience, you might consider a more "bespoke" approach to forensic collections e.g. you may choose to add additional swab sites or exclude swab sites dependent upon the particular circumstances of the case. Always be guided by local recommendations and if deviating from suggested practice, record the reasons for doing so.

Slides

The majority of samples collected for sexual assault cases will be in the form of swabs. In some jurisdictions, examiners are required to make a slide from those swabs in cases where the sample has been taken for the purpose of finding DNA from semen. In other jurisdictions, the forensic laboratory will make their own slides from the submitted swabs. A slide is used as a screening test. Generally, if spermatozoa are seen on the slide, the corresponding swab will be sent for DNA analysis as sperm are recognized as a good potential source of DNA. Slides are not required if a swab has been taken with the view of detecting DNA from other sources such as epithelial cells, blood or saliva.

Some laboratories will assess slides and record estimates of intact spermatozoa. This and sperm density are sometimes used to provide a time since intercourse (TSI) determination. Advice as to the value of this should be sought from the local forensic laboratory.

Some laboratories will test all swabs submitted, some will screen slides first and choose the best swabs to test, and some laboratories will only be financed to test one swab. An understanding of how your local laboratory works and makes these decisions can be useful.

The swabs and containers used to collect forensic evidence differ from those used in clinical tests. They should be DNA free. Most swabs used for this purpose are sterilized with Ethylene Oxide.

Forensic swabs should be placed in plastic sheaths that do not contain transport media or in specially designed boxes that allow the swabs to air-dry. Given the risk of contamination, swabs should not be allowed to air dry prior to packaging.

Blood and Urine samples

Blood samples for drug and alcohol analysis should be placed in containers with a preservative that prevents decomposition and fermentation (e.g. sodium fluoride), and an anticoagulant (e.g. potassium oxalate). All the containers should be shatterproof. Consideration should be given to placing the urine container in a plastic bag in case of leakage.

Lubricants

Water-based lubricants from a single-use sachet (Pedicat® or KY® Lubricating Jelly) may be used to moisten the proctoscope/speculum to facilitate its insertion into a body orifice. The empty sachet should be retained and packaged in a "tamper-evident bag". Sterile water may be used as a substitute to lubricants.

Packaging and Continuity

Any retrieved items must be packaged quickly and efficiently to prevent accidental loss of material and minimize decomposition of the sample. The use of bags with integral tamper-evident seals is recommended to prove that the sample has not been contaminated with exogenous substances since it was sealed.

It is the responsibility of the person who obtains the sample to ensure it is appropriately labelled and sealed. A crisis worker, police officer, or scene of crime officer may assist with the labelling process, but the forensic practitioner must check the labels before signing.

The information on each exhibit and tamper-evident bag should comply with local recommendations. It would generally include:

- Name of person (or reference number) from whom the sample was taken (examinee)
- The healthcare professional's name
- Description of exhibit or site sampled e.g. high vaginal swab
- Date on which the sample was taken
- Blood and urine only – time at which the sample was taken (24 h clock)

Where two swabs have been taken from the same site, it is *imperative* that there is a clear indication on the label regarding the order in which the swabs were obtained. This is most easily done by describing the first of the two samples as sample A and the second as sample B.

Tamper-Evident Exhibit Bags

The use of bags with integral labels will prevent accidental detachment of this vital information.

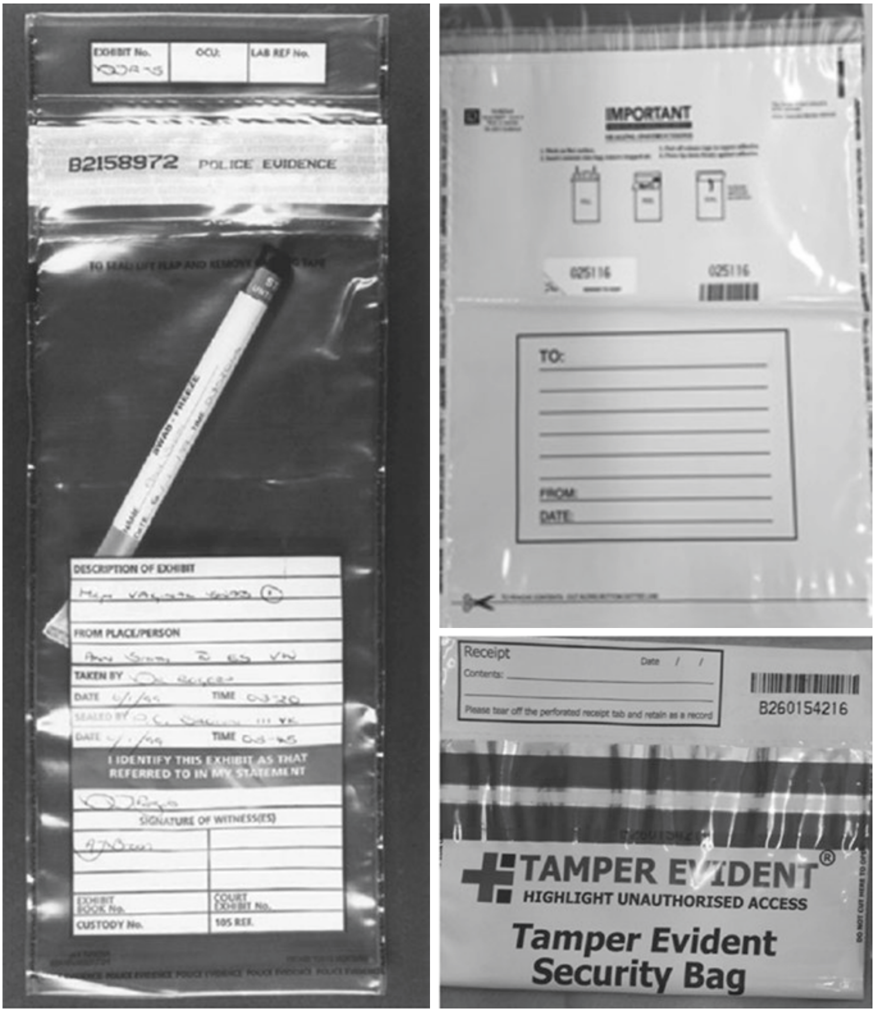

Figure above: Examples of tamper-evident bags.

Clothing

The clothing worn by the complainant during or after the incident may be an invaluable source of information in terms of the nature of the assault (e.g. damage to clothing and body fluid stains) and the identification of the suspect. Even stains on clothing that has been washed have been found to contain sufficient spermatozoa to produce a DNA profile [136, 137]. Ruan et al. showed that 74% of UV treated cotton swatch samples produced DNA profiles after laundry with household garments. Of the mixed profile samples, the majority were from two to three persons with one being a four person mix. They observed that whilst we assume that DNA transfer occurs within the washing machine, there are in fact other opportunities for transfer such as the mixing of clothing in the laundry basket and the varied method of drying clothes [138].

Kulstein et al. observed that a prolonged storage period between semen deposition and laundering resulted in increased DNA quantities and full profiles [139].

Clothing should be placed in paper bags, or into breathable plastic bags, that prevent the accumulation of condensation which could accelerate decomposition of body fluids. Submitted clothing should be sealed and labelled as described previously. When the clothing is overtly wet or possibly contaminated with accelerants, the forensic science laboratory should be asked for advice on packaging and storage.

The forensic scientist must be provided with salient information regarding the incident and subsequent actions of the complainant to determine the type of forensic analysis required. A useful means of transmitting this information is via a pro forma. One example is the Forensic Medical Examination proforma as produced by Faculty of Forensic and Legal Medicine [140].

Analysis

Identification microscopy (e.g. spermatozoa) and immunodiagnostic techniques are used in the identification of body fluids. Microscopy is also used for hairs and fibers, although less commonly since the advent of DNA analysis.

Discovery of the specificity of an individual's DNA profile has considerably enhanced the information that can be provided by a forensic science service (FSS) for connecting a person to an offence and linking offences to each other. Although a detailed consideration of current DNA techniques is beyond the scope of this chapter, a general understanding of the terms and techniques will benefit the forensic practitioner. A useful information source has been provided by the Royal Society of Edinburgh: Forensic DNA Analysis – A Primer for Courts [141].

Except for identical twins, each person's nuclear DNA is unique. An individual's gender and DNA profile may be obtained from any of his or her body fluids or tissues (e.g. blood, semen, and bones). The current technical process used for DNA profiling is termed short tandem repeat (STR) analysis. STR loci are a class of polymorphic markers consisting of simple repeated sequences of 1–6 base pairs in length. STRs are present throughout the human genome (DNA), occurring on average every 6–10 kb along the DNA and may exhibit a high degree of length variation resulting from differences in the number of repeat units displayed by individuals. Their abundance and hypervariability make them ideal markers for the identification of an individual. When a DNA STR analysis is performed, the specific areas of interest on the molecule are initially targeted. Multiple copies of these areas are then produced using polymerase chain reaction (PCR) techniques, which amplify minute amounts of DNA. The DNA pieces are then sorted according to their size, producing the individual's DNA STR profile [142].

DNA STR analysis, including a DNA sex test [143], is part of the routine forensic assessment of biological samples in Europe. The formation of the European DNA Profiling Group has led to the standardization of DNA analysis procedures used in the European community and associated western European countries.

Standard DNA profiling systems used to be focused on the analysis of ten STR loci known as AMPlfSTR® SGMPlus™. This system has been superseded by multiplexes that utilize an increased number of STRs, containing the original 10 SGMPlus STRS plus six more and a gender marker in the case of DNA 17 multiplexes or an extra eleven STRs, two Y chromosome markers, and a gender marker in the case of AmpFISTRGlobalfiler. Increasing the number of loci provides a greater discriminating power but more importantly increases the sensitivity of DNA analysis. These systems contain all of the Interpol and European Networks Forensic Science International (ENFSI) recommended European loci, which provides points of comparison for DNA intelligence purposes outside of the UK [144–151].

When DNA profiling was first applied to forensic science, large amounts of nucleated material were required. However, the use of PCR technology has enabled much smaller amounts of material to be analyzed. Due to the increased sensitivity of the newer multiplexes, DNA profiles can be obtained from ever decreasing amounts of DNA or from poor quality DNA samples e.g. samples of DNA that have become degraded or are mixed with chemical inhibitors.

Y-Short tandem repeats (YSTRs) analysis is a well-established technique routinely used in casework that targets the STR regions located on the Y-chromosome, therefore male DNA only. Over 200 STR markers have been identified on the Y chromosome. Commercial kits are currently available for at least 23 of these [152]. Y-STR analysis has proven successful in detecting male DNA where there has been digital or penile penetration with no ejaculation and in cases of sexual assault where the male has been vasectomized [153]. In these cases, the absence of sperm mean only a small amount of male DNA may be present on intimate swabs and the female's DNA would swamp this. By specifically targeting the Y chromosome STR markers, it is possible to locate and amplify a small amount of male DNA present.

Y-STRs are inherited down the paternal line. As with routine STR testing, Y-STRs vary considerably between unrelated individuals however close paternal line male relatives are likely to share the same Y-STR profile.

Y-STR profiles cannot be loaded to the UK National DNA Database and Y-STR profiling has a lower discriminating power than autosomal STR profiling. Y-STR profiling can, however, provide results in sexual assault cases where autosomal STR profiling has been unsuccessful.

Fluorescence in situ hybridization (FISH) is a technology that uses a fluorescein-tagged Y-specific DNA probe to label male epithelial cells. Once identified, the cells may be separated from the rest of the sample and submitted for DNA profiling. Without separation, the profile may be dominated by female DNA from the examinee, making it difficult to interpret.

Mitochondrial DNA analysis has been used in forensic casework. This technique examines the DNA contained within mitochondria in the cell body and obviates the need for nuclear material [154]. As there are numerous mitochondria in a single cell and each contains multiple copies of the mitochondrial genome, it is possible to extract far more mitochondrial DNA than nuclear DNA. This is useful when cells have become degraded through decomposition or burning. The technique is also suited to discrete samples, such as hairs without roots and for fecal material. Mitochondrial DNA is only passed from mother to child (unlike nuclear DNA, there is no contribution from the father); therefore, all the descendants along the maternal line will have the same mitochondrial DNA. It also has a much lower discrimination power than nuclear DNA profiling. In sexual offences, therefore, the selection of material to be analyzed by this technique is limited and its use needs careful consideration.

The forensic science laboratory must be notified when it is alleged that people who are closely related have been involved in a sexual offence, because their profiles will have greater similarity than profiles from individuals picked at random, and further differentiating tests may need to be performed.

Increasingly in the past few years, messenger RNA (mRNA) profiling has been proposed as a new method of body fluid identification and a lot of research is being carried out in this area. Techniques to use mRNA profiling to distinguish between menstrual blood and traumatic bleeding and buccal epithelial cells from other epithelial cells are being investigated [155, 156].

In addition to the autosomal systems, some laboratories are using DNA quantifiers, e.g. Quantifiler ™ Trio DNA Quantification Kit. This enables detection of amounts of autosomal versus male DNA as well as the quality of the DNA (i.e. presence and extent of degradation). Knowing the quantity and quality of the DNA assists the laboratory in determining the most suitable way of progressing testing.

Skin

The comments in this section refer to non-genital skin.

Areas of skin that have been licked, kissed, sucked, bitten, ejaculated, bled or spat on by either the suspect or the complainant can be sampled. DNA from saliva may also be found with self-lubrication of the penis or fingers. Cellular material, amenable to DNA profiling techniques, has also been identified where there has been skin-to-skin contact (e.g. manual strangulation or gripping the arm) [157, 158]. In a simulated strangulation it was possible to detect victim only DNA in 12 of 29 samples but full DNA profiles of both victim and offender in 7, up to 6 h after touching occurred [158].

Trace DNA

Trace DNA can mean a variety of things:

- It is sometimes referred to as any substance collected for testing to aid an investigation [20]
- It can sometimes be used to refer to samples where the quantity of DNA available for testing is below a certain threshold. This has variously been described as "low template" and "low copy number DNA" [20]
- It can refer to any sample where there is uncertainty that it may be associated with the crime itself [159]
- It can refer, on occasion, to DNA that cannot be attributed to an identifiable body fluid [132]

The small number and nature of these transferred DNA-bearing cells, from skin, often make identification of the cellular source of origin (buccal, epithelial, etc.) either impractical or impossible [160].

Method of Sampling

The double-swab technique, first described by Sweet et al., is the recommended method to recover dried stains or possible cellular material from skin in many jurisdictions [161]. When using this technique, sterile water is used to moisten the cotton tip of the first swab. The tip of the swab is then rolled over the area of skin using circular motions while rotating the swab on its long axis to ensure maximum contact between the skin and the swab. Then, a second dry swab is rolled over the same area to absorb the water left on the skin by the initial swab and collect any remaining cells. Minimal pressure should be applied to prevent exfoliation of the patient's own epithelial cells. It may be important to understand that in the Sweet et al. experiment, only 5 subjects were used. A known quantity of saliva was placed on the skin and testing performed 10 minutes later. The difference between the single swab results vs the double swab results was determined by the percentage of DNA collected in relation to the theoretical amount of DNA deposited on the skin. The single swabs netted 35.3 ± 4.8% vs the double swabs which collected an estimated 44.6 ± 6.4% of the available DNA. This would indicate that, in some cases, the single swab may have had a better result!

Graham and Rutty tested two lines of varying amounts of DNA on a non-absorbent surface, swabbing 15 h later. One line was swabbed with a wet swab and the second was swabbed using both moist and dry swabs. They generated 16 samples and concluded that there was no additional benefit for adding a dry swab [158].

Pang and Cheung collected 20 wet and dry swabs from touched surfaces. Sixteen out of 20 wet swabs were positive for DNA as opposed to 12 out of 20 for the dry swabs. Of the 12 dry swabs, the corresponding wet swab was negative in 2 cases. 5 of the dry swabs returned greater quantities of DNA than the wet swab. Pang and Cheung opined that the second dry swab might collect more DNA if the first wet swab rehydrated the epithelial cells, making them easier to dislodge and collect with the second swab [162].

Hanson and Ballantyne, while comparing DNA profiles from cervico-vaginal swabs, reviewed results from 2 couples where 2 swabs were taken from the same area, expecting that the first swab was more likely to have greater amounts of DNA. Couple 1 demonstrated that more alleles were indeed found on the first swab but the second swab had one allele identified, which had not been present on the first. In couple 4, it was unclear which swab had been done first but alleles were found on each swab not present in the other [163]. It is possible, therefore, that any success noted with the double swab method might be related more to the fact that 2 swabs were collected, rather than the fact that a moist/dry formula is used.

The performance of various types of swabs was tested by NSW Police Forensic Services Branch scientists. They demonstrated that single cotton swabs were equivalent or better than double swabbing in gaining a reportable DNA profile from material on all relevant surface types [164]. It has also been postulated that one possible reason for this is that if the first swab is saturated with water, it might inhibit the amount of material it can subsequently pick up when swabbing the skin. It is therefore recommended that, if using a swab moistened with water, that only one drop of water (or as little as is practical) be used.

Alternative Light Source

Some authors comment that ultraviolet (UV) light causes fluorescence of semen and saliva and advocate its use in determining the areas of skin to be swabbed [165, 166]. This advice must be interpreted cautiously, because a study by Santucci and colleagues found that although many creams and ointments fluoresced when exposed to a Wood's lamp (wavelength 360 nm), none of the 28 semen samples examined did [167].

In addition, other authors have commented that detergents, lubricants (particularly those that contain petroleum jelly), and milk fluoresce [168].

When semen stains are exposed to a high-intensity light source of variable wavelengths (e.g. the Polilight®) and viewed using goggles to block the strong excitation light, semen may be detectable even when the background surface is fluorescent [169]. Furthermore, the location of the stain may be recorded using photography.

Nelson and Santucci have described training forensic physicians to use an alternative light source (the Bluemaxx BM500) to identify semen (100% sensitivity) and to differentiate it from other products [170].

Nolan et al. used an alternative light source (Polilight-Flare®II Plus) to detect seminal fluid on a range of fabrics which were laundered up to 6 times. All unwashed sample materials fluoresced strongly. Fabrics with less absorbency (such as satin, nylon and lace) did not fluoresce following one wash. Following the second wash cycle no fluorescence was visible in any of the fabrics. Conversely, microscopy was positive for cotton and terry toweling after the sixth wash [171].

A survey of several forensic science laboratories in the UK and Ireland [128] found that most felt that using alternative light sources to detect stains on clothing and inanimate materials was of limited value because of the number of false positives and false negatives.

Detection of Saliva

Saliva technically refers to the fluid that originates directly from the salivary glands. Oral fluid, however, relates to secretions from salivary glands, nasal secretions, bacteria and bacterial products, desquamated epithelial cells and food debris amongst other things [172]. DNA that is present in oral fluid is largely derived from the cellular material that is discarded from the mouth.

The only means of identifying the presence of saliva on the skin is by detecting the enzyme amylase. The traditional presumptive test is the Phadebas® amylase test. The Rapid Stain Identification of Human Saliva (RSID™—saliva) can detect human salivary α amylase at lower concentrations [173]. However, amylase can be present in body fluids other than saliva, so in some instances this test is not suitable.

In humans, amylase is expressed on two genetic loci:

- AMY1—salivary amylase—which is abundantly present in saliva with lower quantities found in perspiration and breast milk.
- AMY2—pancreatic amylase—which is found in urine, semen, feces and vaginal fluids [174].

Care needs to be taken with interpretation. The presence of amylase may be a result of secondary, rather than primary transfer.

Cunnilingus and Anolingus

Cunnilingus is the sexual activity in which the female genitalia is licked, sucked, or rubbed by the lips and/or tongue. Anolingus ("rimming") is the sexual activity in which the anus is licked, sucked, or rubbed by the lips and/or tongue.

In some jurisdictions, penetration of the vagina or anus with the tongue, during nonconsensual cunnilingus or anolingus, is considered to be legally analogous to nonconsensual penile penetration of the vagina and anus. For example, in England the offence of "assault by penetration" is defined as nonconsensual penetration of the anus or genitalia by an object or a body part (See definitions at start of Chapter) [175].

Repeated thrusting of the tongue over the edges of the mandibular incisors during cunnilingus or anilingus may cause ulceration of the lingual frenulum, which completely heals within 7 days [176]. Such lesions should be specifically sought during the examination of the suspect's oral cavity when such an act has been described by the complainant or when the precise details of the assault are unknown.

Persistence and Success

In 1992, a study conducted at the Metropolitan Police Laboratory, London, using vaginal swabs from volunteer female donors who had not participated in cunnilingus, revealed high levels of endogenous amylase [177]. Furthermore, amylase has been specifically isolated from cervical mucus [178]. DNA analysis is undertaken on the vulval and/or vaginal swabs. If the suspect's DNA profile is obtained, it can be used to support an allegation of cunnilingus although, obviously, the precise interpretation will depend on whether the complainant was subjected to other sexual acts that could account for the presence of the DNA (e.g. ejaculation, digital penetration etc.).

There is no published persistence data regarding the maximum time it is possible to obtain the assailant's DNA pattern from the female genitalia after cunnilingus/anolingus. It is worth noting that areas of clothing which were in contact with the genitals after such acts can be worth testing as saliva / DNA may have transferred to them.

Several studies have looked at persistence of DNA on skin, thought to have originated from oral fluids.

Graham and Rutty took five volunteers and had their partners deposit saliva on their neck. The following day, DNA profiles from the partners were obtained from the neck swabs of three of the five volunteers [158].

Sweet and colleagues have shown that it is possible to obtain a DNA profile from saliva stains (corresponding to a bite mark) on cadaver skin when the saliva was deposited up to 48 h earlier [179]. In a separate paper they showed the resilience of DNA which had been recovered from the right breast (bite mark) of the deceased body of a female who had been found 5.5 h after being in a river with a slow- moving current [180].

Kenna et al. in 2011 took samples of saliva from three male donors and plated it onto the legs of their three female volunteers. The women were instructed not to wash the affected area. Full male DNA profiles were obtained in all but one combination (n = 8 out of 9) at 96 h [181].

Hair

Hair is most commonly sampled to detect body fluids or retrieve foreign hairs or particles. It has been known for many decades that numerous ingested prescribed and illicit drugs (e.g. barbiturates, amphetamines, opiates, cocaine, benzodiazepines, γ-hydroxy butyrate, and cannabis) are deposited in the hair [182]. Although toxicology of hair was originally used to detect drugs that had been repeatedly ingested, recent advances in analytical techniques have meant that toxicology may be useful after single-dose ingestion as would occur in a substance-facilitated (sexual) assault [183, 184]. This is particularly pertinent because complainants of possible drug-facilitated (sexual) assaults frequently do not report the incident expeditiously because of amnesia and/or doubt about what might have happened, and drugs may be accessible to analysis for longer periods in hair compared to blood or urine [185].

Method of Hair Sampling

Cutting

Hairs should be sampled by cutting if they appear to be contaminated by material that has the potential to have forensic significance (e.g. semen). If the patient does not consent to having the contaminated hairs cut or if it is not practical to cut them because of the extent of foreign material contamination, then the relevant areas can be swabbed.

For drug analysis, hair can be collected up to 6 months (and sometimes longer) following a relevant incident. Sampling should not occur less than 4 weeks after the incident, as it takes at least this long for hair to grow sufficiently from the scalp to enable collection. Examinees should be advised not to cut, dye, bleach or perm their hair in the intervening time. Hair toxicology testing is only done by certain laboratories. Prior to collection it is recommended that the appropriate laboratory is contacted. Who (or what organization) will be paying for the process should be determined (as it is often not cheap). Discussion about available kits and appropriate method for collection and delivery also need to be determined prior to sampling. Hair samples should not be refrigerated or frozen but stored dry at normal room temperature [135].

Foreign Hair

Shed hairs, if in the catagen or anagen growth phase are suitable for routine nuclear DNA testing. Provided a root is present, close to a 100% success rate should be achieved. Most shed hairs (95%) are, however, usually in the telogen phase and contain little nuclear DNA. Mitochondrial DNA can be examined instead. It is a more time consuming and expensive process than nuclear DNA analysis, requires specialist interpretation and has lower random match probabilities [186]. While there may still be a place for macroscopic/microscopic examination of hair, most forensic laboratories have abandoned the practice and available expertise is often limited.

Any foreign particles or foreign hairs identified on the head or pubic hair should be collected with forceps (preferably DNA free) and submitted for analysis [187, 188].

Pubic hairs may be transferred between individuals during sexual intercourse. Exline et al. [189] studied volunteer heterosexual couples who combed their pubic hairs immediately after sexual intercourse in the "missionary" position. Even under such optimal collection conditions, pubic hair transfers were only observed 17.3% of the time using macroscopic and microscopic comparisons. Pubic hair transfer to males (23.6%) was more common than transfer to females (10.9%).

Some studies on sexual offence case material have shown lower rates of pubic hair transfer between complainant and suspect. Mann [190] reported that only 4% of female complainants and no male complainants were identified as having pubic hairs consistent with the assailant hairs isolated from combings of the pubic hair, and Stone [191] identified foreign pubic hairs among the pubic hair combings of 2% of the complainants studied. A survey of sexual offence case material submitted to laboratories throughout the USA, however, found pubic hairs that associated the complainant and the suspect in 15% of cases [192].

Nails

Fingernails should be examined as part of the examination of the hands of a complainant/suspect and any staining/breaks should be noted and possibly photographed.

Sampling

Sampling of nails often occurs if there is a history of a complainant having scratched their offender or if there is an allegation of digital vaginal penetration. In the latter case it will be the suspect's nails that are sampled. Generally, there are two accepted methods used for the collection of fingernail/subungual evidence and these are swabbing and/or cutting of the nail. Most examiners who have attempted cutting someone else's fingernails can probably attest to the difficulty of the process. The current FFLM guidelines for the collection of evidence advise clipping only if visible material can be seen or if a broken nail needs to be matched with a recovered nail fragment [135]. Conversely, the Australian guidelines advocate either process or both if considered appropriate. They recommend a single swab to be used for each nail (ten in total).

When the nail is being swabbed as a result of a history of digital penetration, or if blood can be seen, additional swabs of the nail bed and nail surface are recommended. Nail clippings from each hand can be combined into two separate collection jars i.e. right hand and left hand [193].

Another consideration, when collecting nail evidence, is the type of nail of the complainant/suspect. The nails might be short or acrylic (fake) nails and cutting them might prove impossible. In these cases, the nails should be swabbed. When cutting longer nails it is important to ensure the implement (scissors or clippers) being used has been adequately prepared to reduce the risk of DNA contamination.

Available research looking at preferential sampling methods is limited.

What has been demonstrated:

- Sticks or scissors (sharp objects) should not be used to collect subungual evidence as they have the potential to remove too much of the donor DNA [194].
- The harder a complainant scratches the suspect, the more DNA that can be found on subsequent testing [194].
- The more nails that are clipped and sent for analysis, the better the success rate for finding offender DNA [195].
- Subungual evidence can be collected even if the examinee has washed their hands several times. It may persist up to 2 days following an allegation of digital vaginal penetration [196].
- Fingernail evidence can give rise to the question of background foreign DNA i.e. DNA that might be present and might not bare any relevance to the crime being investigated. In the Cook study the fingernails were swabbed from 100 volunteers and foreign DNA was detected in 13% with only 6% giving reportable mixed DNA profiles [197]. The presence of a mixed DNA profile in a fingernail sample may lead to reasonable doubt in court as to whether the DNA transfer occurred prior to, or during, an assault. Males, in this study, were more likely to provide a mixed profile from fingernail sampling, than women.
- Malsom et al. took 12 couples that co-habitated and swabbed all their fingernails on both hands on three separate occasions. The results demonstrated that as the couples spent increasing amounts of time together, the incidence of mixed DNA profiles increased. 61% of samples gave full or partial donor profiles. 37% exhibited DNA profiles additional to that of the donor [198].

- People who bite their nails were significantly less likely to give a mixed DNA profile, even when the fingernails were swabbed [198].
- A 2015 study suggested that only 4 mm^2 of fingernail sample is required for testing [199].

It is important to remember that foreign DNA found under the fingernails can have an innocent explanation, and care must be exercised when considering this type of testing if the victim and suspect have legitimate access to each other.

Oral Cavity

Buccal Swabs

In sexual assault cases an examiner is often required to collect a baseline sample of the complainant's DNA. This is done with a buccal swab (patient reference swab). Instructions are included in most buccal swab kits. A properly collected buccal swab will provide adequate material for DNA profiling. It is best to do this after any other oral collections have been done. Police will usually collect buccal swabs from suspects.

Oral (Mouth) Swabs

The oral cavity may be sampled when fellatio was performed during the sexual assault or in circumstances in which the details of the incident are unknown. Fellatio (also referred to as irrumation) is a sexual activity in which the penis is placed in the mouth; sexual stimulation is achieved by sucking on the penis while it moves in and out of the oral cavity. Ejaculation may or may not occur. It is common for the semen to be spat or vomited onto clothing where it will remain until washed. Any potentially contaminated clothing or scene samples, therefore, should be submitted for forensic examination.

There is no current worldwide consensus as to what is the best oral sampling method. The following is one suggested method:

Swab the gingival recesses (between lip and teeth), over teeth, back of throat, under the tongue including dentures, dental fixtures and any oral piercings [135].

Success and Persistence

Given the lack of research as to the best site or method of collection it is not surprising that the success rates for sperm detection are appallingly low. 554 analyzed oral swabs, collected in NSW from 2010 to 2015, showed sperm detection in 4.2% (n = 21). All sperm positive samples were collected within 18 h except for one case in which the complainant admitted to post assault consensual oral intercourse with a partner. Of those collected 24 h or more after the assault, all were negative for spermatozoa with the only positive result coming from a deceased person [200].

Lack of success is due to a number of factors which include the hostile environment of the mouth with oral bacteria, enzymes, salivation, eating and drinking all potentially washing away evidence quickly. Although rinsing of the mouth, drinking, and brushing of teeth do not necessarily remove all traces of spermatozoa [201], such activities should be discouraged until the samples have been obtained.

Willott and Crosse [202] reported that spermatozoa are found more often in the saliva sample compared with mouth swabs, but also highlight several cases in which spermatozoa were recovered from swabs taken from specific areas of the oral cavity (e.g. under the tongue, the roof of the mouth, and the lips).

Willott and Allard found spermatozoa on only 9 oral swabs out of 74 tested (12%) [203].

Tucker et al. reviewed 369 cases of sexual assault where there was reported to have been oral involvement. Only 4 cases (1%) resulted in a sample positive for sperm and all of these were examined within 4 h of the assault [204].

A Norwegian study reviewed 22 oral samples and found that none were positive for sperm. All studies were done within 72 h; the majority having been conducted within 24 [205].

Perioral (Lip) Swabs

A moistened swab can be used to collect evidence from around the lips of a complainant or suspect. This might be considered if a history of kissing or licking has been given (DNA from saliva); if there is a history of oral sex (DNA from semen) or if a suspect has placed his hands over the complainant's mouth for a period of time (DNA from epithelial cells).

Analysis of 71 peri oral swabs was performed over a 5-year period in NSW. Sperm was detected on 13 of the samples (18.3%). None were positive after 24 h with the majority positive less than 18 h post assault [200].

Oral Rinses

One suggested method for the collection of oral rinses advises that the complainant places a small amount of sterile water into his/her mouth (up to 5 ml), swishes the fluid around the mouth and through the teeth, then "spits" the contents into a DNA free collection jar. This is then spun down using a centrifuge, usually by the forensic laboratory. The residual cells are examined for spermatozoa and analyzed for DNA.

In the Nittis et al. study, 60 cases were analyzed by the laboratory where there was a direct comparison between oral swabs (taken first) and oral rinses (taken as the second sample). The oral rinse was shown to be a more successful method to recover sperm (17 of 104 submitted samples – 16.3%) and has led to a decision in NSW to abandon oral swab collections in preference for oral rinses. Sperm, in all cases, was only detected when there was less than 18 h between assault and testing [200].

Chewing Gum

Interestingly, sufficient spermatozoa for a DNA profile have also been recovered using standard extraction techniques from chewing gum that was retained in the mouth during non-consensual fellatio [206].

Female Genitalia

In many jurisdictions, the legal interpretation of “vaginal penetration” refers to penetration of the labia and does not require that the penis actually enter the anatomical vagina (See definitions at start of Chapter).

The age at which a female can legally give consent for penile–vaginal intercourse varies from country to country e.g. in England and Australia the age of consent is 16 years.

Forensic science laboratories are frequently requested to determine whether semen is present on the swabs taken from the female genitalia because semen evidence can play a central role in the identification of the suspect. The presence of semen usually confirms that sexual activity has taken place, but the absence of semen on the swabs does not mean that penetration did not occur. The female genitalia should also be sampled if a condom was used during the sexual act and if cunnilingus is alleged to have occurred.

Method of Sampling

Macroscopic examination of the external genitalia should occur before the insertion of a speculum, because even gentle traction on the posterior fourchette or fossa navicularis during a medical examination can cause a superficial laceration at these sites. Whenever possible, the vagina and cervix should be inspected via an illuminated and transparent speculum after the high vaginal samples have been obtained. Colposcopy and the application of toluidine blue dye are two specialist techniques used by some forensic practitioners during female genitalia examinations.

When nonconsensual penile–vaginal penetration is alleged, the swab samples are plated onto a slide and examined microscopically by the forensic scientist to identify spermatozoa and DNA analysis is performed on any spermatozoa found if deemed necessary.

The scientist is able to provide objective evidence in terms of the quantity (determined crudely) and quality of the spermatozoa present and may be asked to interpret the results in the context of the case. When providing expert evidence regarding whether vaginal penetration has occurred, the scientist must be able to rely on the forensic practitioner to obtain the samples in a manner that will refute any later suggestions by the defense that significant quantities of spermatozoa, which were only deposited on the outside of the vulva, could have been accidentally transferred to the high vaginal area during the medical examination [207]. It is worth noting that there has been no research to support or refute this hypothesis.

Areas of the female genitalia that are sampled have been determined historically. Earlier reports document collections at the vulva, low and high vaginal areas. Later, an endocervical swab was seen as being useful if there was a delay in presentation. The original research that underpins this was based on 36 patients [208]. The value of sampling three internal genital areas (vulva, low and high vagina) is uncertain, other than to increase the chance of collecting DNA by collecting three samples. What can be inferred about depth or likelihood of penetration from DNA/sperm only found at one of these sites, or assessments made based on the amount of semen seen at these sites, is uncertain and any opinions on such should be approached with caution until further research is available.

Other potential genital or nearby areas for swabbing include the external labial area, the mons or perineum. It should be clear in the examiner's mind what anatomical areas are being sampled when submitting a "vulval" swab or "external labial" swab as these may differ from examiner to examiner or from unit to unit.

External Labial

In cases where cunnilingus is alleged (licking of the female genital area), swabs of the external aspect of both labia majora can be collected using a moistened swab. The external area is considered to be the skin side (or potential hair bearing aspect) of the outer vaginal lips (labia majora).

Vulval

The vulval swab, in NSW for example, is sampled from the lower half of the vaginal entrance, between the inner aspects of the lower ends of both labia minora, including the fossa navicularis. UK FFLM recommendations suggest that the vulval swab will include both the vulva and perineum and that all genital swabs include both a moist and dry sample [135].

Low Vaginal

The vagina anatomically originates at the hymen. A low vaginal sample is taken by introducing the swab into the lower part of the vagina, past the hymen (or hymeneal remnant).

High Vaginal

This should be collected using a speculum. If lubricant is used, specify the type of lubricant for the forensic laboratory. In most cases the speculum can be inserted with no lubrication but insertion should be done slowly and carefully. The swab is inserted through the speculum into the vagina and a sample is taken from the top of the vaginal vault. There will be some circumstances when a speculum cannot be used and then the high vaginal sample is called a blind high vaginal swab. The swab is introduced into the vaginal vault and progressed carefully as far as it will go. It is, in fact, a trans-vaginal swab, sampling all areas of the vaginal vault. Whether or not a speculum has been used should be identified in the case notes.

Endocervical

The endocervical sample should be taken from the cervical os. It is not necessary to introduce the swab through the os, as done with Pap smears, but merely sample the cells at the os opening. There has been some suggestion in the literature that if the os cannot be visualized, the cervix might be sampled anywhere along its length. Joki-Erkkila et al. [209]. demonstrated that the combination of an endocervical swab and a cervical canal brush could extend the time period for Y-DNA positive samples (up to 144 h – 6 days). It should be noted that cervical brushing can result in bleeding. The possibility of introducing a bleeding site (and thus a portal of entry for sexually transmitted diseases) should be weighed against the benefit likely to be obtained from a positive DNA sample.

Urine

Spermatozoa have been found in post assault urine samples. In some cases, where spermatozoa were not found via microscopy, Y-STR quantification (and, in theory, profiling) was still possible. Joki-Erkkila et al. [210] found the quantity of measurable male DNA was higher (median 0.68 ng/μl) in the post coital urine sample when compared to vaginal swabs (median 0.06 ng/μL), cervical swabs (median 0.02 ng/μl) and cervical brushings (median 0.02 ng/μL).

Speculum

In the process of sampling the vagina, the speculum may accumulate body fluids and trace evidence. Therefore, the used speculum can be retained, packaged separately, and stored in accordance with local policy. If the speculum is visibly wet on removal, swabbing may be undertaken to retrieve visible material. If storage space is restricted, swab the instrument and retain the swabs instead.

Seminal Fluid

Normal semen has an odor similar to bleach (sodium hypochlorite). 60% of the semen volume originates from the seminal vesicles, 20% from the prostate, 5% from spermatozoa and the remaining 15% is comprised of various gland secretions e.g. Cowper's and Littre's glands.

Sperm are created in the testes and stored in the epididymis, travelling to the urethra via the vas deferens during ejaculation. Semen has a volume in the range of 1.5–5 ml [211].

Acid phosphatase is found abundantly in the prostate gland and, therefore, in seminal fluid. In most laboratories, the Brentamine test [212] is used to detect acid phosphatase. However, acid phosphatase is also found to a lesser extent in vaginal secretions, so further confirmatory testing is necessary to determine whether the fluid is semen. Usually this is microscopy to visualize spermatozoa but under some circumstances (e.g. vasectomy) spermatozoa may be absent from semen.

If no spermatozoa are detected, an attempt is made to confirm the presence of semen by other means. Some laboratories use immunological tests such as Seratec prostate-specific antigen (PSA) [213–215] or The Rapid Stain Identification (RSID™) test for semen [216]. The latter is an immunochromatographic strip test, which uses two monoclonal antibodies specific for human semenogelin.

Because the PCR DNA techniques are now so sensitive, it is often possible to obtain a DNA profile from cellular material present in the seminal fluid even when no spermatozoa are present.

Blood

Whenever bleeding is noted during the medical examination, the forensic practitioner should communicate to the scientist any possible source for the bleeding (menstrual, trauma or unknown). When no explanation for the bleeding was given the presence of blood must be interpreted with caution, particularly if in small quantity, because traces of uterine blood may be present at any time of the cycle.

Even though work is still being undertaken to determine the source of DNA, Tozzo et al. (2018) [217] ascertain that tissue specific mRNA detection not only can provide these answers but provides additional benefits:

- It has high sensitivity due to the possibility of PCR amplification
- High specificity due to the pattern of gene expression
- Unique for the functional status of cells and organs
- Can obtain simultaneous DNA isolation without material loss
- mRNA is quite stable in forensic stains.

Success and Persistence: Adult Female

In a 3 year review of results obtained from sexual assault patients in NSW the following was observed:

- 368 high vaginal swabs were tested. 280 were positive and had been tested within 48 h of assault; 12 of the positive samples had been tested between 48 and 96 h with only 1 positive result being found between 4 and 7 days after the assault.
- 77 cases, where both a low vaginal and high vaginal swab was tested, the results matched in 64 cases but differed in 13.
- 84 cases, where both a low vaginal and vulval sample was collected, the results matched in 71 cases but differed in 13 [218].

Janisch revealed that 46.5% (53 out of 114) who had vaginal samples collected within 12 h of their alleged assault had samples that were positive for sperm. 43.1% (22 out of 51) were positive when examined between 12 and 24 h post assault. No sperm was detected in their study (213 people) 3 days post assault [205].

Owers [219] presented results from a large scale study of 2269 cases of penile–vaginal penetration sexual assault allegations. In this study spermatozoa were detected in 32% of the cases analyzed where the alleged offence had occurred 3–4 days previously, 16% where the alleged offence had occurred 4–5 days previously, 20% where the alleged offence had occurred 5–6 days previously, and 7% where the alleged offence had occurred 6–7 days previously, significantly above the level detected in other publications. This study highlights that TSI data is significantly affected by the sperm recovery method used during the initial examination of vaginal swabs for the identification of the presence of semen and that much of the published data in relation to time since intercourse (TSI) intervals and the expected persistence of semen in post-coital samples relates to extraction methods which are no longer routinely used in casework by many forensic laboratories. Although it is widely recognized that the expectation for obtaining a DNA profile increases as the level of recovered spermatozoa increases, this study also demonstrated that with enhanced sperm recovery techniques there is an increase in the number of single source male DNA profiles and ‘usable’ mixed DNA profiles (i.e. mixed DNA profiles for which a clear major or more prominent male contributor could be determined) from seminal pellets with low/trace levels of spermatozoa and that with the increase in sensitivity of current DNA techniques that nearly all (95%) of the seminal pellet samples submitted for DNA analysis in this study provided usable DNA profiles.

While longer times for persistence are the exception rather than the rule, caution should be taken when these time periods are obtained from older research. Note that semen will persist in dead bodies for much longer time intervals.

The quantity of semen in the vagina will diminish progressively with time, usually as a result of drainage. The posture and activity of the complainant subsequent to the act are likely to affect this. Similarly, washing, douching, or bathing may accelerate the loss of semen. Drainage of semen from the vagina may also result in soiling of intimate clothing items worn at the time, and these can prove valuable sources of body fluids.

It has been observed that spermatozoa can be isolated for longer periods in the endocervix. Studies that compared paired swabs from the vagina and cervix have found that 2 days or more after vaginal ejaculation there is a larger quantity of spermatozoa on endocervical swabs compared with the vaginal swabs [220]. It is recommended that where possible, therefore, an endocervical swab be taken in addition to the swabs from the vagina. It has been shown, in some jurisdictions where endocervical swabs are only taken after 24 or 48 h post assault, that these samples can be accidentally forgotten if they do not form part of the routine female genital collections [221].

Time Since Intercourse

There is interest in the possibility of determining the timing of intercourse. Opinions have been formulated in the past by looking at a combination of the detection of prostatic acid phosphatase (AP), detection of prostate specific antigen (PSA/p30), the identification of spermatozoa using microscopy and the density of sperm and/or presence of intact sperm (spermatozoa with tails).

Dziak et al. have proposed that rough time estimates might be established by looking at vaginal smears. Many sperm, including intact sperm, has been estimated to indicate time since intercourse may be up to 72 h, but likely to be within 24 h. Few sperm (including intact sperm) or many sperm (with no intact sperm) are likely to be seen within 72 h of intercourse. Few sperm (none intact) is likely to represent intercourse that has occurred within the last 7 days [222]. These determinations are relatively subjective as they require forensic scientists to estimate whether few or many sperm are seen and whether few or many are intact. This method of scoring has been used for about 40 years. In 2015, Tobe et al. tried to assess the reliability of the scoring system by developing slides with random dilutions of seminal fluid and asking 37 examiners to assess the slides. Each slide was assessed by a minimum of 25 investigators. On no slide was there a consensus between all scores. Sperm were not seen 56 times (9.6%) and 27 investigators (73%) did not see sperm on at least one slide. Their opinion was that sperm scoring was highly subjective and there was room to improve the objectivity of the ratings [223].

Success and Persistence- Pediatric female

Given the anatomical development of the female genitalia with age, it is possible that different sampling approaches (with regards to time for cut off periods) should be considered especially for pre-pubertal girls. Persistence of spermatozoa in the vagina of young children is thought to be markedly reduced because they have decreased cervical mucus [224] and shorter (and hence smaller) vaginal cavities. Christian et al. reviewed the medical records of 273 children aged under 10 years. All children had been examined within 44 h of the alleged/suspected sexual assault. No swabs taken from the child's body were positive for sperm/semen after 9 h. The majority of forensic evidence was gathered from linen or clothing and it was recommended that these forms of evidence should be collected in every case where possible to do so [225].

Nittis and Stark (2014) reviewed NSW sample results. The pubertal status of the complainant was not known and an assumption was made that if the child was aged 11 years or younger and no attempt had been made to obtain a high vaginal sample that they were likely to have been pre-pubertal. 105 samples, fitting this criteria, had been tested. 15 of the positive samples for obtaining a DNA profile had come from skin (n = 5), underpants (n = 7), vulva (n = 1), the penis (n = 1) and the anus (n = 1). The positive vulval sample had been collected within 6–12 h following the alleged assault and the positive skin / penile samples were all collected within 12 h [221].

For the above reasons, female genital sampling of pre-pubertal children is undertaken, in NSW Australia, in cases where 24 h or less has passed since an alleged/ suspected assault.

Colposcopy

A colposcopy has historically been performed using a binocular microscope. Many centers, particularly those in the USA, advocate the use of the colposcope for external and, where relevant, internal genital and / or anal assessments of complainants of sexual assault.

The colposcope can provide considerable advantages over gross visualization. First, it provides magnification (5–30 times) and greater illumination, enabling detection of more abnormalities. The abnormalities that are detected by magnification but missed by macroscopic examination are likely to be small injuries only, the significance of which might be controversial.

Second, with the attachment of a still or DVD video camera, the colposcope allows for a truly contemporaneous, permanent video/photographic record of the genital/anal findings. If a DVD video is used, it will document the entire genital examination and will show any dynamic changes, such as reflex anal dilatation and movement of the hymen. If appropriate, the medical findings can be demonstrated to the complainant and carer.

Finally, if a remote monitor is used, the whole examination can be viewed by another doctor for corroboration or teaching purposes without additional parties having to be present during the intimate examination. Ensure consent is obtained if this method is being used.

The use of colposcopes is not without issue. Some examiners have difficulty with binocular vision and find the equipment difficult to use. Colposcopes have, historically, been expensive pieces of equipment that occupy large amounts of space and were often not portable. There are now many options available on the market, including cameras that project only onto a monitor (no binocular vision required) and can be packed into a bag and transported where needed. Prices have reduced substantially.

Obviously, it is important that in all cases the colposcopic evidence be interpreted in the context of the information that is currently available regarding colposcopic assessments after consensual sexual acts [88, 114, 115, 226–228].

Toluidine Blue and Fluorescein

Toluidine blue stains breaches of the keratinized squamous epithelium, binding to nuclear material of tissues, and can highlight lacerations of the posterior fourchette that are not apparent on gross visualization [229, 230]. Use of toluidine blue increased the detection rate of posterior fourchette lacerations from 4% to 58% in adult (older than 19 years) complainants of nonconsensual vaginal intercourse, from 4% to 28% in sexually abused adolescents (11–18 years old), and from 16.5% to 33% in pediatric sexually abused patients (0–10 years old) [230, 231].

In contrast, adult complainants of nonconsensual vaginal intercourse and sexually abused children had significantly more lacerations demonstrable by toluidine blue staining than control groups [230].

Vulval swabs for forensic analysis must be taken before the stain is applied. Toluidine blue (1%) is then painted on the posterior fourchette, using a swab, before any instrumentation. After a few seconds, the residual stain is removed with lubricating jelly and gauze [229]. This is potentially messy and can result in residual staining of underpants, if care is not taken. The patient may experience some stinging at the application site. The time parameters within which the use of toluidine blue is beneficial in highlighting injuries have not been identified.

In March 2017, Kathryn Laughon [232] postulated use of another dye to highlight injury. Toluidine blue was thought to be less efficient when used on darker skin individuals because of the lack of contrast between the dark blue stain and the dark skin. She has proposed the use of Fluorescein which has been widely used in ophthalmology. The dye enters the space between cells, becoming more concentrated in areas where cell membranes have been disrupted or cell death has occurred. In her research Fluorescein improved detection of injury from about 37% (when not used) to 99% (when used), which was similar to her findings for toluidine blue. She also found that it did not appear to interfere with DNA typing. As Fluorescein does not depend upon contrast to be seen, it should work effectively across all skin types.

Male Genitalia

Method of Sampling

After an allegation of fellatio, swabs from the complainant's penis can be examined for saliva, and an amylase test may be carried out. It is worth remembering that amylase may also be present and detectable on underwear that was in contact with the penis after the deposition of the saliva [233]. DNA profiling can be carried out on the swabs or clothing. When an allegation of vaginal or anal intercourse is made, penile swabs from the suspect can be examined for cells, feces, hairs, fibers, blood and lubricants.

It should be noted that there is the potential for vaginal fluid from recent previous intercourse, unrelated to the allegation, to be detected by DNA analysis of swabs taken from the unwashed penis. In one reported case DNA, from the complainant's boyfriend, was found on the suspect's penis [234].

Data collected by the MPFSL between 1987 and 1995 [235] have shown that after vaginal intercourse, cellular material from the complainant can be recovered from the coronal sulcus (groove around the penis just below the glans) even if the suspect has washed or bathed since the offence. Swabs taken from the meatus and urethra are not suitable for microscopic assessment because some male urethral cells can be similar to vaginal cells [236].

Current Faculty of Forensic and Legal Medicine guidelines for the collection of penile samples suggest 2 sampling areas. The first area is the penile shaft (including the external foreskin covering the glans, if present) and the second area is the coronal sulcus (and internal foreskin, if present) [135]. Some jurisdictions advocate a further third sample area, the glans. The swabs must be labelled accordingly, and the order in which the samples were obtained must be relayed to the scientist. The same samples are also taken if it is believed that a lubricant or condom has been used during a sexual act or if the assault involved fellatio or anal intercourse.

DNA STR profiling of body fluids on the penis is the method of choice used to provide evidence of penile–vaginal/oral/anal contact. It has proved particularly useful when multiple suspects have had intercourse with a single complainant [234], because DNA STR profiles matching the other suspects may also be found on the penile swabs taken from one suspect.

Success and Persistence Male

Female DNA profiles have been obtained on penile swabs up to 24 h post-coitus [237].

Karrstadt et al. [238] reviewed results from 227 cases, over a 3-year period, and found that in 57% of cases, no suitable material was found from the penile swabs. 26 of the remaining 97 provided a DNA profile of the female. They found that success was more likely in those cases where the male had penetrated three body orifices i.e. mouth, anus and vagina. The finding of Lugol positive cells also resulted in a better rate of success for DNA profiling. No success was found after 15 h.

The above study may have had relatively poor success rates as, with all sexual assault cases, it is uncertain whether penetration, as described, has occurred. Farmen et al. (2012) used 11 volunteer couples who provided 14 post-coital penile swab samples between 5 and 24 h post intercourse. All males were asked not to wash prior to sampling. Samples were collected from the coronal sulcus. Between 5 and 12 h, 90% of samples recovered full female DNA profiles. Female DNA was recovered from all samples and a full female profile was discovered from one couple at 24 h [239].

Cina et al. looked at the potential for isolating male and female DNA from post-coital condoms. Swabs were taken from both the internal and external condom surfaces during one penile vaginal encounter where a condom had been used, 8 h previously. As expected, female DNA could be found on the external surface and male DNA from the internal surface [240].

Perianal Area and Anal Canal

Buggery is a lay term used to refer to penile penetration of the anus (anal intercourse) of a man, a woman, or an animal (also known as bestiality). Sodomy relates to anal intercourse between humans only.

Sampling

The presence of semen in the anus or rectum can be corroborative evidence of alleged anal intercourse in conjunction with the presented history and possible physical findings.

Be aware that sperm sampled from the anal canal in women may not necessarily be the result of penile anal penetration. It has been postulated that the presence of spermatozoa within the anal canal/rectum may be a result of drainage from sperm deposition into the vagina or surrounding area. The evidence base for this is limited and largely relies upon research from Davies [212], Enos and Beyer [241] and Willott [203], published between 1974 and 1982.

It might be more accurate to assert that a positive finding from the anal swab, especially when sperm numbers are low, may be a result of secondary transfer. It seems no more likely that semen leaks past the anal sphincters into the anal canal than water does, when swimming or having a bath. Contamination may be iatrogenic i.e. occurred during the forensic procedure or it may be a result of everyday activities e.g. toileting.

Swabs should also be taken if a condom or lubricant was used during the sexual assault and if anolingus is alleged.

Sampling should start from the most external point and subsequent samples should be taken in an internal direction. The first site sampled is usually, therefore, the perianal area using a moistened swab (or double swabbing method if recommended in your jurisdiction). This is followed by sampling of the anal canal, just distal to the external anal sphincter. As it is possible to introduce DNA from the perianal area into the anus when collecting forensic evidence it is suggested that an examiner use a method of sampling that reduces, as much as possible, the chance of this occurring. One option is to wash the perianal area, after sampling, with sterile water and gauze, and prior to anal sampling. In all cases, separation of the buttocks for several seconds will result in the relaxation of the external sphincter. A swab can be introduced about 1.5 cm into the anus (just past the sphincter) and removed using the same caution, decreasing the potential for the swab to touch the perianal skin.

Sampling from the lower rectal area, if required, should only be done using an anoscope/rectoscope/proctoscope. Measures should be taken to reduce the potential for contaminating the swab during collection and during removal of the swab from the body. This should be the last sample collected and the swab should be taken just distal to the proctoscope, being careful not to touch the instrument when withdrawing the swab.

Water-based lubricant from a single-use sachet (Pedicat® or KY® Lubricating Jelly) may be used to moisten the proctoscope to facilitate its insertion into the anus. If lubricant is used, it should be noted on the form returned to the forensic scientist.

In the process of sampling the rectum/anal canal, the proctoscope may accumulate body fluids and trace evidence. The used proctoscope can be retained, packaged separately, and stored in accordance with local policy. Alternatively, if the proctoscope is visibly wet on removal, swabbing may be conducted to retrieve visible material.

Stool samples and toilet paper need not be collected routinely because the other samples described should be adequate for laboratory requirements.

Condoms and Lubricants

Traces of lubricant found on vaginal or internal anal swabs may provide confirmatory evidence of recent penetration of a body orifice. This has particular relevance if a condom is worn during a penetrative act.

While the wearing of a condom might reduce/eliminate DNA found from biological evidence, trace lubricant might be detected, the presence of which might help support whether a crime has occurred, corroborate the version of events provided as well as assist with determining whether penetration has occurred [242].

Consequently, if the forensic practitioner has used lubricant (other than sterile water) on specula, proctoscopes, it must be communicated to the forensic scientist. The most commonly encountered lubricants applied directly to the penis to aid penetration are Vaseline® (petroleum-based product) and KY® Jelly (water-based product) [243]. Various other substances have been used to facilitate penetration during a sexual assault including hand cream, cooking oil and margarine, the diversity of the products apparently reflecting what is immediately at hand. Saliva is also used as a lubricant.

The constituents of condom lubricant (e.g. polydimethylsiloxane (PDMS) and polyethylene glycol (PEG)) [244] are also found in numerous other skin care products and suppositories. Therefore, when relevant, the forensic practitioner should ask whether the complainant has applied anything to the genital/anal area in the preceding 2 days [245]. This information should be noted on the paperwork that is made available to the forensic scientist so that the scientist can source the relevant product to check what it contains. The same dusting agents are used on some clinical gloves. Therefore, the forensic practitioner should wear nonpowdered gloves when sampling the genital and anal area [246].

To maximize the possibility of lubricant detection, the necessary swabs should be obtained as soon as possible after the incident. If the practitioner is aware that condom lubricants may be an issue, lubricant should not be used on the speculum or proctoscope during the examination. The forensic science laboratory must then be told that lubricant analysis may be relevant, because this potentially requires scientists from more than one discipline to examine the same sample, e.g. when both body fluids and lubricant analysis are requested. If the forensic science laboratory is not made aware of this requirement, potential evidence could be inadvertently destroyed during laboratory processes.

Many factors may affect the length of time that a lubricant will persist on skin or in a body orifice. Condom lubricant has been detected on a swab taken from an unwashed penis 50 h after intercourse and, in a different case, on a vaginal swab (also when the complainant had not washed or douched) taken 24 h after intercourse, but detection after such prolonged periods would appear to be exceptional. Water-based lubricants (e.g., those containing polyethylene glycol) have only been detected within 8 h of the sexual act [243, 247].

Success and Persistence Ano-rectal Samples

Under normal circumstances, semen is unlikely to persist in the anus for more than 24 h. The maximum recorded interval between the act of anal intercourse and the identification of spermatozoa on a rectal swab is 96 h [203]. In one exceptional case, however, where a female lay prone in the hospital for several days because of injuries sustained during a sexual assault, semen was detected on anal swabs taken 113 h after the act of anal intercourse [203]. These results were published in 1982. More recent research has not replicated these time periods.

Janisch found that only 7 anal swabs out of 37 (18.9%) were positive for sperm, when taken within 24 h of assault [205].

More recently, a review of NSW forensic results demonstrated that of the 105 anal/rectal samples collected and tested for DNA only 36 resulted in a usable profile. All were collected within 48 h of the alleged assault. Of the 63 perianal samples tested, 19 were positive for DNA and had all been collected within 24 h [221].

Swabs should be taken even if the complainant has defecated since the assault. An unpublished review of 36 MPFSL cases of alleged anal intercourse in which the complainant had defecated before the examination found that in six cases (four female and two male) the internal/external anal swabs were still positive for spermatozoa, although only a few were present; one of these subjects, a male, had a positive external anal swab 52 h after the anal intercourse (Allard J, personal communication, 1998). Anal swabs have produced a positive DNA STR analysis up to 48 h after the incident (Elliott K, personal communication, 2003). Obviously, it would be preferable to avoid defecation and urination before sampling but it is acknowledged this is not always practical.

Blood and Urine Analysis

When drugs or alcohol have been consumed or possibly administered before or during a sexual assault, consideration should be given to the need to obtain samples of blood and urine for toxicological analysis. The length of time that a drug or its metabolites remain detectable in blood or urine depends on several factors, including the quantity taken, the individual's metabolism, and the sensitivity and specificity of the analytical methods used by the laboratory [248]. Although the metabolites of some substances may be excreted for up to 168 h in the urine [248], many are detectable for only few hours. In general, drugs and their metabolites will be identifiable for longer in urine than in blood.

The limit of detection is the lowest concentration of analyte that the analytical process can reliably differentiate from the background.

The limit of quantitation is the lowest concentration of analyte that can be reliably identified and quantitated with a certain degree of reliability.

Method of Sampling

Cut off periods for the collection of blood and urine may differ between jurisdictions and from case to case. Current FFLM recommendations suggest blood should be collected if the incident occurred within the last 3 days and suggest urine sampling up to 5 days [135]. Samples from complainants do not need to be witnessed.

Ideally, a forensic toxicology kit should be used. Wipes that contain alcohol should not be used to clean the skin before the blood sample is taken. If volatiles (e.g. amyl nitrate) are suspected, a portion of blood must be collected into a separate container.

Analysis

Forensic science laboratories have the capability of detecting a range of prescribed and illicit substances, but the persistence of different substances or their metabolites in the blood and urine of an individual depends on numerous factors.

Certain information may be required to assist the forensic scientist with interpretation of the toxicological results:

- Sex and body weight
- The time that any drugs/alcohol were consumed (start of consumption and when consumption ceased)
- Did the complainant have an alcoholic drink after the incident and prior to the medical examination?
- The exact time/date that the blood and urine samples were taken
- Details of any prescribed medication or other substances normally consumed by the individual, including quantity and the date and time of most recent use

Persistence Data

The detection windows depend on a few different factors, including the amount of substance used / administered and the frequency of use. Specialist advice is often available from the toxicology section of the local forensic laboratory.

Note that long acting drugs that may persist up to 5 days in urine include Methadone, long acting benzodiazepines e.g. clonazepam and nitrazepam (as well as diazepam), and possibly ketamine. The z-drugs (Zolpidem and Zopiclone) may be seen in urine up to 3 days (See Chap. 12).

Early Evidence

Some Sexual Assault units facilitate the collection of early evidence samples. The UK Forensic Science Service with Metropolitan Police developed one of the very first early evidence kits in 2001 [249]. Other services have developed their own variations in the two decades since. They are most useful for the collection of evidence that might otherwise disappear quickly, e.g. oral samples. Other samples that lend themselves to early collection include blood for toxicology (although this needs to be initiated by a health care practitioner), urine samples for biological evidence or toxicology, oral rinses, and “wipes”/swabs/equivalent for the early collection of vaginal and anal samples. All examiners that work for units that have access to these kits should be very familiar with their components and be able to provide necessary advice on techniques for their utilization. If considering early collections, and no current guidelines exist in your jurisdiction, please consult your local forensic laboratory for advice about the best sampling methods.

Early evidence collection, if available, may be the responsibility of police, hospital emergency department staff or forensic examiners. In all cases, chain of custody should be maintained and recorded.

At time of writing there was limited literature concerning the efficacy of early collection samples. Smith et al. 2014 [250] reviewed 88 alleged sexual assault cases that presented to their unit. Both early evidence and full forensic specimen collections were obtained for each. Early evidence samples included oral swabs, oral rinses, first void urine, vulval and peri-anal wipes and “other” (including sanitary items). Spermatozoa was detected in 35% (22/63) of early evidence kit first void urine specimens and 32% (18/57) of early evidence vulval wipes when penile vaginal penetration had been alleged. Spermatozoa was detected in 40% of cases where vaginal swabs were then taken by a forensic examiner as part of a full forensic assessment. These results appear to indicate that a urine sample more successfully results in offender DNA evidence than a wipe (although the difference may not be statistically valid). Gaining a urine specimen from a patient is relatively easy to do, most patients have experience with the process and this type of sample could be facilitated by non-medical personnel such as police. For these reasons, it may be a preferable choice over a “wipe” or self-collected swab.

When the allegation was penile anal penetration, spermatozoa were found in 33% (2/6) of early evidence anal wipes and in 67% (2/3) cases of early evidence urine samples (when there had been no allegation of successful penile vaginal penetration). Spermatozoa were found in 36% (4/11) of cases where a full forensic was conducted. Although case numbers are small, the suggestion is that sperm recovered from a urine sample can't be assumed to have been deposited in the vagina.

When the allegation was penile oral penetration spermatozoa was only detected in one early evidence oral rinse (1/18) but in none of the full forensic oral samples [250]. The numbers were, however, quite low.

Joki-Erkkila et al. [210] opined that during voiding, vaginal secretion flow was increased secondary to the relaxation of the pelvic floor and the increased intra-abdominal pressure. This would be one reason for the apparent success in voided urine being analyzed not only for toxicology but for sperm/DNA. In their research 88 volunteers collected various post coital urine samples following consensual intercourse. There were 205 urine specimens in total. The samples were centrifuged and the resultant cell pellet was sent for Y STR testing. Y DNA was measurable in 84.4% of samples. This increased to 96.5% of samples when the urine was the first post coital collection. Most specimens were collected within 24 h of coitus. After 24 h Y DNA was measurable in 40.9% of samples (9/22). The researchers considered the cut-off limit for identification of the male at ≥0.01 ng/μL Y-DNA. 74.6% of all samples returned this amount of Y-DNA. Not surprisingly, the percentage of positive samples decreased in proportion to the void number i.e. less Y-DNA was found in the sixth to tenth voids when compared to the first post coital void. It should be noted these results were based on Y-STR quantification PCR as opposed to Y-STR profiling [210].

Early Evidence kits are self-collected in many cases. This self-collection may be facilitated by non-forensic medical and nursing staff or by other emergency workers such as police or ambulance officers. As potential forensic evidence it needs to survive challenges in court with regards to chain of evidence, collection technique and potential cross contamination. Despite this, there seems little doubt that this type of evidence has a valuable place in sexual assault assessments.

Products of Conception

Occasionally forensic examiners may be asked for advice, or to participate in, the collection of products of conception for the purpose of identifying an alleged sexual assault offender. It is recommended that guidelines around this type of sampling should be available if required. They should be designed in consultation with police and forensic laboratories and updated regularly. Some general principles have been outlined below:

Informed consent should be obtained, as per any forensic collection procedure. In some jurisdictions, the procedure will not be carried out unless a report has been made to police. The type of fetal sample will depend upon the type of termination procedure. Medical terminations can be done up to 9 weeks, suction curettes up to 12–14 weeks and dilatation and evacuations generally from about 14 weeks onwards.

Most laboratories will require an estimated date of conception and will accept a tissue sample, rather than the entire fetus. All equipment used should be sterile and preferably disposable. Formalin should not be used and a chain of custody should occur, with documentation of every step in the process, including who handled the specimen. A medico-legal report documenting the receipt, sealing, storage and handover of the specimen may be required.

Prophylaxis

The risk of contracting a sexually transmitted infection following a sexual assault may differ vastly from city to city, state to state and country to country. Every attempt should be made to locate local guidelines that base their recommendations on local prevalence and incidence rates. Included below is some general information but forensic examiners should consult local pharmaceutical texts.

Ideally, guidelines should exist to assist a complainant's access to STI prophylaxis medication regardless of whether or not they consent to a full forensic examination. Complainants should be advised to practice "safe sex" until all results have been returned and they have been successfully treated for any infections.

Pregnancy

Female complainants at risk of pregnancy must understand that the efficacy of all emergency contraception decreases as the time since assault increases.

There are three options that might be considered for a complainant who, as a result of an assault, may be at risk of pregnancy. These include:

Copper IUD (Intrauterine Device)

Although not always considered first line, because training and experience are required to have them inserted and removed, they do offer some benefits over other choices. Once inserted they will work for up to 10 years. As Marie Stopes Australia has observed, it is the cheapest option around for contraception costing less than "a Netflix and Abstinence" approach [251]. It is the only long term, hormone free, reversible contraceptive on the market. It has a failure rate of less than 1 in 100 and doesn't require a woman to remember to take anything. The copper IUD can make tails separate from the body of sperm. As Marie Stopes has observed, "Makes it kind of hard to get to the egg when you can't swim." Lastly, it is the most effective form of contraception available, working for up to 120 h after unprotected sex. It should be considered as a first line option in those women who have a body mass index >25 kg/m^2 as there is a decline in efficacy of Ulipristal Acetate and Levonorgestrel as BMI increases [252].

Ulipristal Acetate 30 mg

This is a single dose treatment.

There is a demonstrated improved efficacy of Ulipristal, when compared to Levonorgestrel, for the prevention of unwanted pregnancies when taken within the 0–120 h post intercourse period. A reduction in pregnancies of about 2.15–1.36% (if taken within 72 h of intercourse) has been demonstrated [253].

If the woman also has been taking a medication (or herb) that induces cytochrome P450 CYP3A4, or had treatment with these medications in the previous 4 weeks, there may be a decrease in the efficacy of Ulipristal as Ulipristal is metabolised by CYP3A4. Patients should be offered an alternate form of contraception such as a non-hormonal emergency contraceptive e.g. copper intrauterine device or 3mg (double dose) Levonorgestrel [254, 255].

If vomiting occurs within 3 h after ingestion of the medication the dose will need to be repeated.

Ulipristal is thought to prevent ovulation by suppression of the LH (luteinising hormone) surge for at least 5 days, which is beyond the lifespan of sperm. The effects post-fertilisation are currently unknown. The timing of ovulation cannot be predicted and if ovulation has already occurred Ulipristal may not be effective.

If a woman wishes to initiate or resume regular hormonal contraception after using Ulipristal, they should be advised not to commence hormonal contraception sooner than 5 days after the intake of Ulipristal AND to use a reliable barrier method until the next menstrual bleed. Breast feeding should be avoided for 1 week after ingestion of Ulipristal.

Levonorgestrel 150 mg

This is a single dose treatment. It has limited evidence of efficacy after 3 days (72 h) [255, 256].

Women requiring post exposure pregnancy prophylaxis must be asked specifically about whether or not they may be taking any cytochrome P450 3A4 inducers as the dose may need to be doubled i.e. 3 mg stat, however bear in mind evidence for efficacy is lacking [254].

The forensic examiner must advise that, if vomiting occurs within 2 h after ingestion of the medication, the dose will need to be repeated. Vomiting is, however, uncommon.

The possible mechanisms of action of Levonorgestrel include:

- Prevention of ovulation
- Altering the transport of sperm and egg through the tube
- Changing the lining of the uterus in a way that may discourage implantation.

Because Levonorgestrel does not interrupt an established pregnancy, defined as beginning with implantation, it is not considered an abortifacient [256].

Hepatitis B Prophylaxis

Hepatitis B is covered in detail in Chap. 10.

The forensic examiner may assume a potential risk of Hepatitis B, following sexual assault/rape, if there has been a penetrative sexual event (excluding digital penetration) AND the assault was thought to have occurred within the previous 7 days AND there is no history of a complete Hepatitis B vaccination.

Booster doses may not be recommended for immune-competent persons who have completed a primary course of Hepatitis B immunisation. There is good evidence that a completed primary course provides long lasting protection even when antibody levels decline with time and become undetectable [257, 258].

Human Immunodeficiency Virus (HIV)

Generally there must be an occasion of receptive intercourse (i.e. penile anal or penile vaginal), there must be an offender who is either HIV +ve or from a group that is considered high risk e.g. men who have sex with men, from a high HIV prevalence country etc. and the penetrative event must have occurred within the last 72 h in order to be offered HIV prophylaxis.

In order to quantify the potential risk to a complainant an examiner needs to know the risk associated with the type of exposure that has occurred (e.g. for cases of receptive vaginal or anal intercourse, insertive vaginal or anal intercourse etc.). This is multiplied by the risk of the source being HIV +ve. These are very location specific statistics. Whether or not HIV post exposure prophylaxis should be offered is generally determined by the potential risk i.e. exposure risk x source risk.

Unaids website [259] provides up to date sero-prevalence of individual countries for HIV (use the key population atlas). A high prevalence country (HPC) is any country with sero-prevalence of the general population >1%. As an example, at time of writing, sub-Saharan African countries and sex worker contacts from South and South East Asian countries were considered to be high prevalence populations.

Note also that the sexual exposure risk in children is higher than in adults due to the increased risk of mucosal trauma, vaginal wall thinness and cervical ectopy [260].

Animal studies suggest that the sooner HIV Post Exposure Prophylaxis (PEP) is given, the greater the chance of preventing seroconversion. Therefore, it is currently recommended that HIV PEP is commenced no more than 72 h after the assault [261] and, like most prophylactic medication, the sooner it is commenced the more effective it is likely to be. Many sexual assault referral centers provide starter packs to ensure rapid access to the appropriate medicines. Patients considering HIV PEP should be advised of the unproven efficacy, potential side effects, and the fact that the long-term consequences are not fully understood [262]. If HIV PEP is given, baseline serological tests should be obtained. The recommended course of treatment is generally for 4 weeks, and patients should be monitored by a genitourinary physician during this period.

Chlamydia

There are two schools of thought with regards to Chlamydia prophylaxis. Those that recommend post exposure prophylaxis are likely to do so because sexual health follow up rates of sexual assault complainants is often poor, Chlamydia Trachomatis infection may be asymptomatic and can lead to serious morbidity if untreated (infertility, ectopic pregnancy, chronic pelvic pain, arthritis, peri-hepatitis, proctitis, epididymo-orchitis), prophylactic treatment is easy to administer in a stat dose, is well tolerated and has few drug interactions, sexual assault victims are often young and therefore in the highest risk group for Chlamydia.

Some of the reasons to not recommend prophylaxis include the fact that the presence of any pre-existing Chlamydia infection is unknown, there may be inadequate contact tracing, Chlamydia is easily treated at follow up if STI check is positive and prophylactic treatment may discourage patients from seeking STI follow up if they believe they have already been treated.

Other Prophylactic Treatments

Gonorrhoea is not a particularly common infection seen in sexual assault victims in Australia and so routine prophylaxis is generally not prescribed, although this may depend upon the location of the sexual assault unit. There is an increased prevalence rate in some indigenous communities.

Prophylactic Treatment and Testing for Suspects

In cases of alleged sexual assault, all suspects should be advised to attend a Sexual Health / Genito Urinary Medicine (GUM) clinic for STI screening. A suspect has the same right to access post-exposure prophylaxis in a timely fashion [263].

Baseline STI Testing

Recommendations regarding this are likely to differ. It does offer an opportunity to target an at-risk population who may be unlikely to follow through with a sexual health appointment. Urine and swab sampling, if positive, may not however necessarily represent the infection status of the complainant but, rather, the infection status of the offender resulting in unnecessary anxiety or treatment i.e. if swabbing the vulva after non-consensual ejaculation, the sample might be a mix from both the complainant and the offender.

Expertise and Peer Review

> *The overriding objective of this procedural code is that criminal cases be dealt with justly. Dealing with a criminal case justly includes acquitting the innocent and convicting the guilty, dealing with the prosecution and the defense fairly, recognizing the rights of the defendant…* [264].

Forensic examiners, dealing with sexual assault complainants and suspects, should be aware of any potential conflicts of interest and instructing parties must be informed of this as soon as practicable [265].

Every examiner who works at the medicolegal interface should be aware of bias (over 20 different types have been identified) as they can influence decision making and opinions.

Examiners should be engaged in a process of continuing professional development in order to demonstrate continued competency in their area of expertise [265].

The expectation that there should be peer review of a statement, prior to its submission to court, is likely to increase. Peer review may occur in different ways. A reviewer may read a statement and offer comments about grammar, spelling and the opinion reached based on the evidence cited in the certificate/statement. A reviewer may, however, additionally review contemporaneous material collected at time of examination, for example original injury diagrams, patient histories and photographs. It is the latter, arguably, which should allow the reviewer to reach an independent assessment of the information that was available to the primary examiner. If a statement has been peer reviewed, should this be identified within the statement? Should a list of the materials reviewed be specified? Should difference of opinions be recorded for the court and when should this be done? Should reviewed drafts of statements be kept and presented to court upon demand? It is likely that examiners who work within sexual assault units will need to consider the pros and cons of each course of action and develop guidelines for staff to ensure a consistent and transparent approach.

Conclusion

Aiming for perfection is only likely to lead to disappointment. Aiming for improvement is much more achievable. It is important, therefore, to review each case after it has been performed in an attempt to identify what was done well and what might have been done better, where there were shortcomings in knowledge and how that information might be more readily accessed on the next occasion, where the system failed and where we failed. Replicating the things that worked well and improving upon the things that might have been done better will ensure competency in this area of clinical forensic medicine.

The UK Forensic Science Regulator provides updated advice on pertinent issues, including the Forensic Medical Examination Standard—Adult and Child Sexual Assault Complainants. This latter document contains a self-assessment table and is one way to ensure your service and practice meets acceptable standards [389].

Key Points

- It is essential that injuries are documented in detail in the clinical notes, describing the injury in writing, drawing on a diagram, and by imaging (photograph or video). High quality documentation requires all three.
- Examiners should be aware of the principles behind forensic sampling and local guidance should be regularly reviewed to ensure that the samples taken are appropriate and evidence based that is, based on the experience of local forensic laboratories (statistically and not anecdotally), as well as published research.

Self-Assessment Exercises

1. Which forensic samples would be required following an allegation of penile penetration of the vagina within the previous 48 h?

2. Outline the psychological response to rape and what support you could offer to a victim of sexual assault?
3. How would you manage the risk of pregnancy and sexually transmitted diseases in a complainant of sexual assault?

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Injury Assessment, Documentation, and Interpretation

4

J. Jason Payne-James, Margaret M. Stark, Maria Nittis, and Douglas R. Sheasby

Learning Objectives
Ability to demonstrate accurate documentation of injuries in various forms.
Describe the classification of injuries.

Introduction

One of the most important functions of any healthcare professional (HCP) (doctor, nurse or paramedic) is the ability to assess, document and interpret visible injuries, wounds, cutaneous marks, or scars, which may have been sustained as a result of trauma or violence. Crimes of violence occur worldwide and are manifest in many ways, whether inter-personal, part of armed conflict, civil war, military intervention, accidental, from torture, or terrorism. The incidence of crimes of violence varies from country to country and may be dependent on many different factors, including political upheaval and mass forced migration. For the purpose of this chapter the definition of injury used is [1]:

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damage to any part of the body due to the deliberate or accidental application of mechanical or other traumatic agent.

The latter term would include heat, cold or chemical agents.

In the UK recently there are changes in the lower-volume but higher-harm types of violence, with increases in homicide and offences involving knives and sharp instruments, but decreases in offences involving firearms [2]. Worldwide there is much greater awareness of the issues of cruel, inhuman and degrading treatment and torture(CIDT) in those who are detained in a wide variety of detention settings [3, 4]. HCPs, particularly forensic physicians and forensic pathologists, are often involved in assessments of individuals who have made complaints. This chapter addresses the issues of physical assault and the assessment and documentation of wounds, injuries, cutaneous marks, and scars.

The aim of assessment and documentation is to assist in establishing how the recorded mark, injury, abnormality, or scar has been caused—and this is often the essence of medical evidence in courts and tribunals. The HCP's role may also be to explain the clinical relevance of the absence of visible injury or marks following allegations of assault and trauma. The skills of assessment and documentation are ones that should be within the remit of any doctor (and within the remit of appropriately trained HCPs), but sadly this is now rarely taught in medical schools. Additionally, immediate medical care and treatment may supervene in more serious or life-threatening injury meaning that useful forensic documentation near the time of injury may be lost. The interpretation of the causes of wounds, scars, and injuries should be undertaken by those with specific forensic expertise, as there may be many factors involved in such interpretation [5].

Interpretation requires the best quality evidence, which may include ambulance records, hospital records, operative notes, and photographic images. Increasingly high quality images from a variety of sources including smartphones, body worn video cameras (BWC) and CCTV may be available. As interpretation of wounds, cutaneous marks, scars, and injuries is frequently undertaken by review of documents without physical examination of the patient—for example, using written descriptions, body diagrams, or photographs—it is imperative that the descriptions of what is seen are clear and unambiguous. For example, the word "wound" has specific meaning in certain jurisdictions. In England and Wales it refers to the skin or mucosa being completely breached and there is specific case law for guidance:

- Both the dermis and the epidermis must be broken (*Moriarty v Brooks* (1834) 6 C & P 684).
- A scratch or break to the outer skin is not sufficient if the inner skin remains intact (*McLoughlin* (1838) 8 C & P 635).
- An internal rupture of blood vessels in the victim's eyes will not amount to wounding within s20 (*JCC (A Minor) v Eisenhower* (1984) 78 Cr App R 48).

This definition may affect both the nature of any criminal charge brought and the subsequent sentence if convicted. In many cases the initial examination and assessment may have been undertaken for purely therapeutic purposes, and the forensic significance of the injuries may not become apparent until many weeks or months later. Scrutiny of the contemporaneous records at a later stage, may reveal serious deficiencies in documentation, which not only undermine the credibility of the individual practitioner, but can also seriously prejudice the legal proceedings. Pediatricians, primary care physicians, gynecologists and emergency medicine specialists are examples of those "non-forensic" practitioners who may treat patients with injuries that may become the subject of argument within court proceedings.

Assessment and Documentation

The key to appropriate assessment and documentation of injury is to apply routine medical processes, which are the taking of an appropriate history from the patient (or complainant/complainer or suspect) and the undertaking of an appropriate physical examination. The findings of the history and examination must be recorded contemporaneously, clearly, and unambiguously. If a case goes to court, all such documentation (e.g. contemporaneous medical notes—handwritten or electronic—including body diagrams) may be reviewed critically by others including doctors, lawyers, judges and juries. Consent for the examination and for subsequent production of a medical report should routinely be sought from the individual being examined. It should also be remembered that false, vexatious, or frivolous accusations of assault are made, and the professional undertaking the assessment should be aware that false allegations and counter allegations do occur which may only become obvious much later. Therefore the 'Gold Standard' for the documentation of injuries includes the following:

- The documentation of injuries clinically by a suitably qualified practitioner in the field of clinical forensic medicine
- Within an agreed timeframe
- There must be clear contemporaneous notes that can be interpreted by other HCPs—the defense expert if necessary
- Supported by body diagrams and photographs
- Expert interpretation as to causation

Limitations

Occasionally, there may be factors that impinge on the quality of the examination. These should be noted and may include:

- Seeing a patient in an unusual site e.g. in a bed in a ward rather than in a dedicated forensic examination suite
- Poor lighting
- Multiple interruptions

- The complainant's emotional status
- The actions of relatives/friends

Key Factors to Consider when Taking a History

Table 4.1 identifies the most important factors which may have relevance in the examination of anyone with injuries and which should be considered when the history is taken from the injured person.

It is important to document the time at which the injury was said to have occurred as the appearance of injury following assault is time-dependent. Assaults may not be reported for days or weeks afterwards. In the case of CIDT or torture, or non-recent child abuse, many years may have passed. In some cases, the only evidence may be fully healed and mature scars. In some cases there may be no evidence. There may be a number of injuries from different incidents at different times. Each injury, cutaneous mark or scar should be considered separately. Specific time frames should be sought for each injury. If more than one type of assault has occurred, clear records must be made of which injury was accounted for by which implement. Document the handedness (left or right or ambidextrous) of both complainant and suspect if known, as this may affect the interpretation of injury causation. Even if it doesn't, recording it shows that it has been considered. Contradictory accounts may be given by different witnesses—it is not the HCP's role to determine which account is necessarily the correct one, but to use medical knowledge applied to the evidence presented to assist the court in determining the true account. In many cases, the medical interpretation is neutral.

Whether an injury is intentional or accidental is difficult to say as there are often no unique features and hence why a global assessment of the patient is required with detailed history and comprehensive examination [6]. Such accounts may also be influenced by the effect of drugs and/or alcohol and it is appropriate to assess the influence that these may have in each case (see Chap. 12). Knowledge of the type of weapon used can be very important when assessing injury as particular implements

Table 4.1 Example of Factors & Questions to Consider When Assessing Injuries

How did you sustain the injury? Use open-ended questions
Weapon or weapons used (is it still available?)
What time was the injury sustained?
Has injury been treated (e.g. glued or sutured)
Are there pre-existing illnesses (e.g. skin disease)
Is regular physical activity a factor (e.g. contact sports)
Are you on regular medication (e.g. anticoagulants, steroids)
Handedness of complainant and suspect
Use of drugs and alcohol (complainant and suspect)
What clothing was worn?

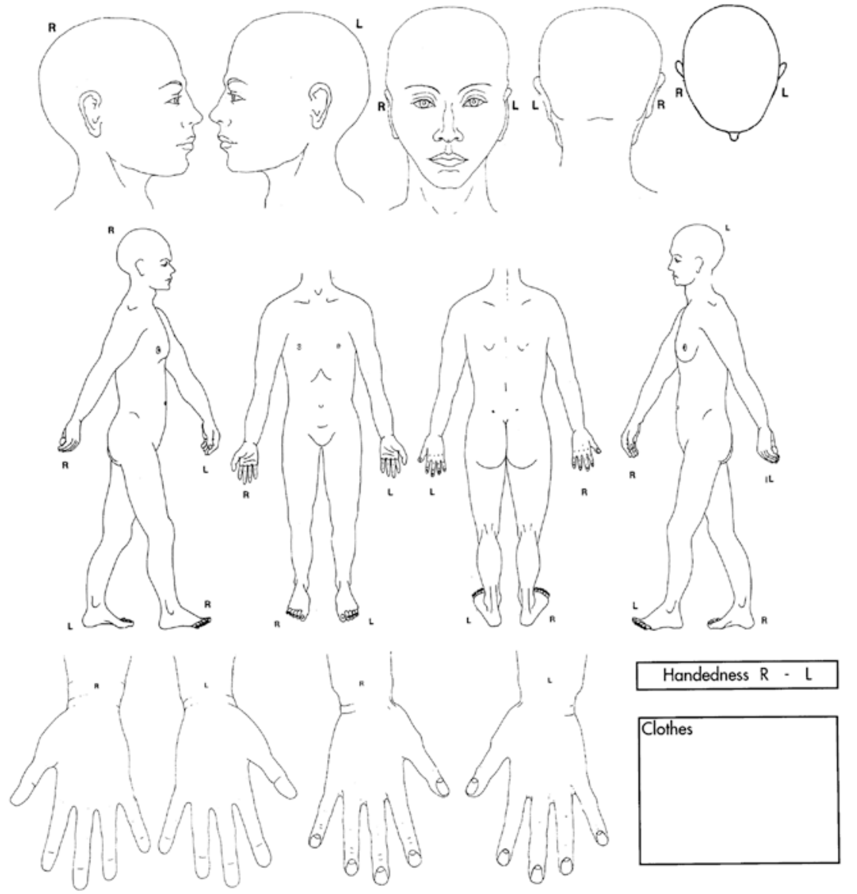
may cause recognizable, identifiable injuries (e.g. police batons, knuckledusters, footwear). The type of clothing worn (e.g. long sleeved shirts, leather jackets, armless vests) should be noted as these may modify the expected nature of the injury. It should be noted if there was damage to clothing at the time of the assault. When examining any individual for injury, all these features should at least be considered to see whether they may have relevance to the case. Additional features may assume significance as the examination progresses, or as other accounts of any assault are given, or additional forensic evidence becomes available at a later date. Ensure that a full body examination is performed or at least offered as there may be injuries underneath clothing that the patient is unaware of.

Actual documentation of injuries can be in a variety of formats, including written descriptions, hand-drawn notes, annotated proforma body diagrams, photographic or moving images. Figure 4.1 illustrates examples of a body diagram and note proforma. Table 4.2 lists the characteristics of each injury that may be needed for appropriate documentation.

Forensic Imaging

The notion that a line drawing of injury by one examiner compares equally to a photograph that can be peer reviewed by others, is highly irrational, given the standards of evidence based medicine…It is potentially an injustice to a victim not to offer the option of photo-documentation, just as it is equally a potential injustice to the defendant, who has the same right to expect the capture of all possible evidence that may influence the outcome of the case against them [7].

Forensic photography has one primary purpose and that is documentation of clinical findings. Digital photographic images have now become a common way of documenting injury, but the digital image evidence should only support the evidence from properly documented contemporaneous written descriptions and hand-drawn notes [8, 9]. Photographic images should rarely be used as a sole source of medical evidence. The Faculty of Forensic & Legal Medicine of the Royal College of Physicians (FFLM) has produced guidelines on such photography [10]. Apps are now available on smartphones and tablets that can allow documentation of injury, body diagram production, and photographic documentation, which accurately geolocates and times the examination and outputs an editable document (e.g. ForensiDoc®). Ensure that, at the time of examination, the patient is given an opportunity to explain how the injury occurred. Consider whether the injury seems consistent with this explanation. If an injury does not seem consistent with the account given, question it at the time, without leading the patient. In many cases individuals who have been involved in fights or violent incidents are simply unaware of the causation of many sites of injury. Re-examination of injuries or sites of injury 24–48 h after initial assessment is of use to see how injuries evolve and whether bruises have appeared, or other sites of injury noted. Pre- and post-treatment examination and photography is often very useful. Photographs should be taken with a scale/rule and consideration should be given to using a color scale



Handedness R - L

Clothes

No other injuries observed or complained of ☐ Time of injury ☐ Time of photographs ☐

Samples taken:

.../1-	at	h	.../4-	at	h	.../7-	at	h
.../2-	at	h	.../5-	at	h	.../8-	at	h
.../3-	at	h	.../6-	at	h	.../9-	at	h

Additional samples:...

Given to...at.................h

I consent* to a full examination and/or taking of samples and/or taking of photographs for educational purposes including publication in scientific & medical journals, books and all other media including electronic and am aware that formal reports/statements may be prepared from these notes for police, court and other purposes, and I consent to such reports/statements being made: *** delete as appropriate**

Name .... Witness *(name and signature)*

Signed ....

Fig. 4.1 Examples of a body diagram and note proforma

Subject Name ....

Examiner Name ....

Date of Examination ....

Time of Examination ....

Reference Number ....

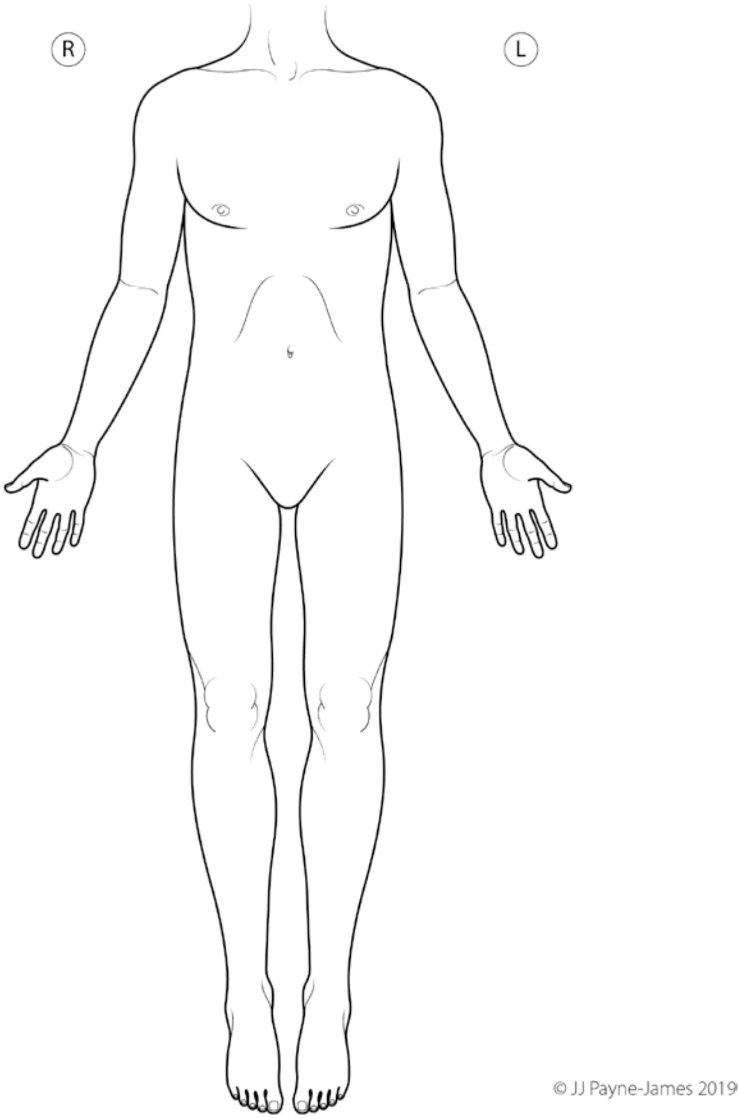


Fig. 4.1 (continued)

Subject Name ....

Examiner Name ....

Date of Examination ....

Time of Examination ....

Reference Number ....

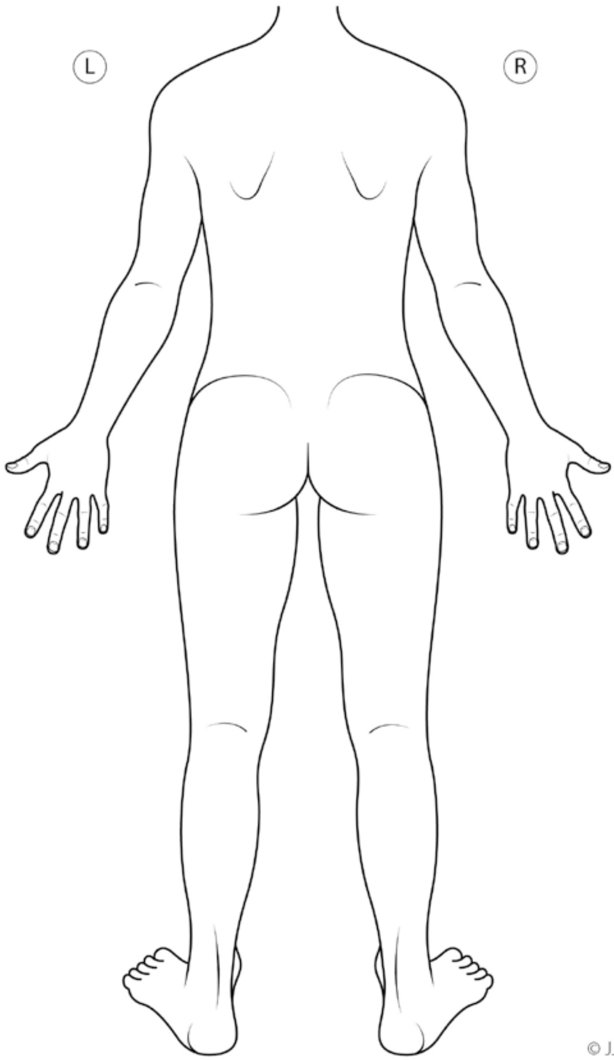


Fig. 4.1 (continued)

Subject Name ....

Examiner Name ....

Date of Examination ....

Time of Examination ....

Reference Number ....

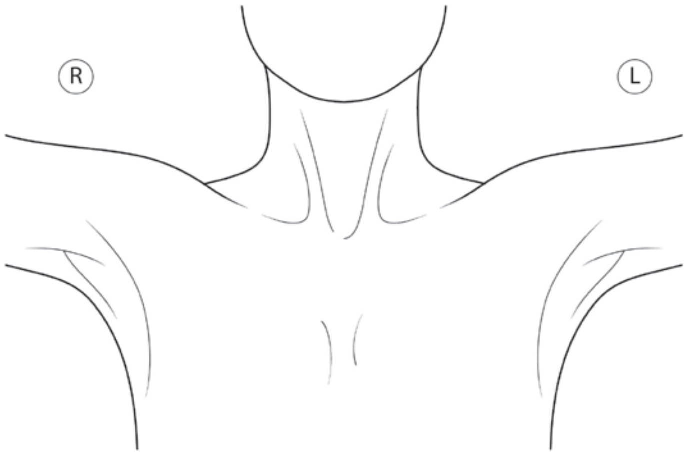


Fig. 4.1 (continued)

Forensic Medical Assessment (this is not a statement/report for court) Reference #

Forename Family Name Consent XM St

Reason for XM: Detain Interview Charge Other Mental Health Sexual

Location Date Arrival Start XM Finish XM Chaperone

Date of Birth Employment Marital Status Ethnicity

Address Alleged Offence

History Risk Assessment Education/Family/Social/Development

R /Allergies /Sickle cell Cell/Examination Room First language/country of origin/interpreter

PMH/PSH/Assault Drugs/alcohol/cigarettes

PPH/Self Harm Drugs (within 24h)

PGH Alcohol (within 24h)

Injuries - restraint – assault – police

Demeanour Appearance Gait Speech Orientation: Time Location Reason

CVS
BP S/D

Temperature

RS

Glucose

AS

O_2

NS

Scars/DF

GCS KO

Skin

Vision

Mental state
Behaviour
Mood
Speech (form)
Thought Content
Auditory/Visual Hallucinations
Abnormal Beliefs/Experiences
Delusions
MMSE Score

Previously Assessed (Y/N)
Previous Arrest Information (Y/N)
Summary Care Record (or equivalent (Y/N)

Substances
Nystagmus
FN
FF
Rombergism (30 sec)
OL
HT
RD
Sweating
Tremor

Gooseflesh
Needletracks
Rhinorrhea
Lacrimation
Yawning
Pupils
Other
Nausea/vomiting
Alcohol

Summary/ Management

Risk: Raised Standard

CCTV (Y/N) L 1 2 3 4

(Boxes and headings are for guidance only and need not be filled in or completed)

Fig. 4.1 (continued)

Table 4.2 Potential relevant information required when assessing injury

Location
Pain
Tenderness
Limitation of movement
Type of injury (e.g. bruise, incised wound, abrasion)
Size (use metric values and rules or scales with color chart e.g. Forensigraph®)
Shape
Color
Orientation
Age
Causation
Handedness
Time of injury causation

(e.g. ForensiGraph®). The color of an injury rarely provides much useful forensic information.

Secondary purposes for photo-documentation may include, amongst others:

- An aide-memoire for the examiner
- Review by peer, mentor or colleague
- Evidence for court
- Evidence to assist in the investigation of a crime
- Teaching and education
- Research
- Assessment of injury healing/change over time

Photo-documentation is an important tool in the production of factually based clinical conclusions (see below). When an HCP is required to document an injury, it should be completed in the most comprehensive manner possible, within limits imposed by patient consent and legislation. A digital SLR (DSLR) camera is the best device for taking high quality images. Consideration should be given to purchasing a camera that can be readily serviced and has compatibility with available equipment (lenses, electronic flash etc.).

A dedicated camera for the purpose of photo-documentation of injuries is suggested. Capture of images using a phone or tablet is not recommended. Although the images from these devices may 'look good', there can be issues that make reliable interpretation of the image technically difficult particularly due to image distortion in the absence of rules and scales. Furthermore, images captured on mobile devices have significant security consequences that could damage patient confidentiality and may breach organization policy.

It is vital that training on how to use the camera has been undertaken. All cameras will have their own specific characteristics and features and examiners need to be familiar with how to turn it on, where batteries are stored/charged and how they are inserted, how to go back to original settings or default (in case someone has inadvertently made changes), how to operate the flash, how to review the images, how to interpret exposure histograms, how to delete photos and how to download them etc. It is also critical that the settings in the menu are appropriate for the shooting conditions, including the color temperature of the light source (white balance setting).

Photo-documentation should not be attempted until guidelines, procedures and/or policies are in place. These should address the following issues:

- The type of camera and lens that is being used and appropriate settings
- Storage of the camera, battery, flash and lenses
- The correct date and time is set on the camera (for obvious reasons relating to court evidence)
- Digital storage of resultant images
- Review of images by examiners and how this is going to occur
- Transmission of images e.g. to the Court, Police, Prosecution, Defense, Examiner, Reviewer
- Guidelines re: retention of or destruction of images
- Consent of the patient
- The need to record, within a person's medical record (if appropriate) or within an Expert Certificate or Statement, that photographs have been taken.
- Ownership of images (do they belong to a Health, Justice, Police organization, the patient or to the examiner)
- Handling of sensitive images (e.g. ano-genital or breast) [11]

An examiner should also give some thought as to how these images will be presented in court. Ideally, if used they should be presented to the trier of fact in their original digital format as this will provide an image with the most information and detail. Most commonly, photographs are printed out on non-photographic paper and scanned. This will reduce detail to such an extent, in some cases, that the injury may not be recognizable.

Occasionally an examiner might be asked to provide an opinion on an injury from photographs alone, not having the opportunity to examine the patient personally. In these cases, it might be wise to consider the following:

- Providing a disclaimer as to the limitation of injury interpretation from photographs alone.
- Refraining from any comment about color, especially if there is no inclusion of a color reference card.
- Refraining from any comment with regards to specific size unless a scale with cross hairs has been included, the cross hairs are equal in size and the scale is adjacent to and on the same plane as the injury. Comment about approximate sizes might still be reasonable.
- Be extremely careful when commenting on photographs that have been provided in any format other than their original digital format. This includes photographs that have been converted to a PDF, scanned, printed, photographed from a computer screen or sent in a reduced size format. Comment might still be possible

but it is often worthwhile noting the less than ideal image format that has been provided.

It is recommended that an examiner consults an expert in forensic photography before submitting or providing any written or oral opinions when made directly from photographic sources.

Types of Injury

Any practitioner who is involved in assessment of injury for court purposes must understand the range of terms that can be applied to different injuries. It is essential to have a consistent system of description that ensures that the nature of each injury is understood clearly, reproducibly, and unambiguously in note form—utilizing accepted terms of classification. The confusing assortment of terms used by doctors and other healthcare professionals often results in problems in court. The classic example (for good reasons) is the inappropriate or inaccurate use of the term "laceration" to describe a cut which can, if applied incorrectly, potentially alter the causation of a wound from one caused by a sharp instrument such as a knife, to a blunt impact such as a punch. This may have substantial impact on the charge applied and the sentence if convicted [12]. For medicolegal purposes, a standard nomenclature must be adopted when describing injuries. Although there are a number of classifications of injuries in papers and other textbooks, the classification shown in Table 4.3, is simple and clear and most injuries can be classified in this way. These injury types are expanded on below.

Inflicted injury (whether deliberate/intentional or accidental) may be divided into two main types—blunt impact (or blunt force or blunt contact injury) and sharp implement injury. Blunt injury simply describes injury not caused by instruments or objects with cutting edges. Blunt force injury can be caused in many ways, both direct (e.g. punch or kick) and indirect (e.g. by traction, torsion, and shear stresses) [13]. Injury is caused by impact with the object, either while moving towards or away from it. It is very important to understand the nature of the blunt force and there are many studies that illustrate the varied nature of blunt forces and physical settings in which blunt force can be sustained [14–18]. Examples of objects that can cause blunt impact injuries include fists, feet, baseball bats, impact rounds and police batons. Blunt force injuries are dependent on a number of factors including force, location (underlying organs or structures), and impacting surface. They can cause a range of symptoms and signs which range from no visible evidence of injury, to tenderness (pain on pressure at the site of contact), or pain at the site of contacts, reddening, swelling, bruising, abrasions, lacerations, and broken bones. There may be internal hollow and solid organ damage. Each type of injury may be present alone or in combination (a mixed type injury). Such injuries are generally seen at the point of contact of impacting object on the body, but if there are shearing forces injury may be sustained also away from the site of apparent contact. Forces applied to one point of the body may cause

Table 4.3 Classification of injuries

Wheals and erythema (reddening)
Bruises (sometimes referred to as contusion, ecchymosis)
Hematoma (a fluctuant collection of liquid blood)
Petechiae (small hemorrhages)
Abrasions
Grazes scuff/brush abrasions
Linear abrasions, point abrasion
Lacerations
Incisions
Slash
Chop
Stab
Firearms
Burns
Thermal (heat and cold)
Chemical, radiation, electrical

injury to another site e.g. as might occur when the brain moves within the skull cavity resulting in a contra-coup brain injury. Bruises may migrate away from the point of contact by gravity after a period of time or track down ligamentous sheaths and through tissue planes. Abrasions give a clear indication of the actual site of impact, whilst bruises may not necessarily indicate the site of the impacting object.

The appearance or pattern of an injury or mark may indicate whether a particular implement or type of implement was used (e.g. a police baton with a distinctive tip outline), or a cluster of injuries may suggest a mechanism (e.g. a hand grip). The amount of force used to create an injury is influenced by many variables (most of which are unknown) e.g. moving towards the offender, moving away from the offender, force applied to a limb that is fixed in position (e.g. head against a wall) so there is no dissipation of energy, force to skin where underlying bone is close to the surface, clothing worn, implement used. The estimate of force used is fraught with difficulty and liable to be interpreted by the trier of fact as an indication of the level of intent to do harm.

A blow to the side of the head from, e.g. an open-handed slap across the ear, may result in rupture of the tympanic membrane and so examination of the ear and external auditory canal should be performed. Symptoms may include pain, bleeding, hearing loss, tinnitus, and vertigo. Many blunt contact injuries may cause initial pain and discomfort—which resolve within a few minutes, and tenderness—which may still be elicited hours or days later—with no visible sign of injury. Absence of visible injury does not imply that no assault or injury has taken place.

Sharp injuries are those caused by any implement with cutting edges (e.g. knives, scissors, glass, razor blades). The incised wounds that result may be variable with the cutting edge running tangentially to the skin surface, cutting through skin and deeper anatomical structures; or where the sharp edge penetrates the skin into deeper structures.

The forces required to cause sharp injuries and the effect of such injuries are variable as a very sharp pointed object may penetrate vital structures with less force than a non-sharp object. In general, even with sharp implements, at least moderate force is required to penetrate skin, which is very robust. The force may occasionally occur from the victim who runs towards or falls into a sharp object held stationary by an offender. Generally, the skin offers most resistance to penetration (with the exception of bone and cartilage). The less sharp the object, the higher the likelihood of a mixed type injury (has both blunt and sharp force features), see Table 4.4 e.g. chop type injuries from weapons such as machetes or Samurai swords or axes [19–23] (Table 4.5).

Force of Injury

In considering the force required to cause an injury - force must have been applied but as to how much force it is not possible to determine accurately [24]. The amount of force varies directly with the mass of the weapon and directly with the square of the velocity of impact. This is again dependent on a number of factors including the area over which the force is applied, the duration and direction of application, mobility of the body part, biomechanical properties of the tissue hit, and the anticipation and co-ordination of the person hit [25].

Table 4.4 Features of certain incised wound/penetrating injuries

• Scissors will produce a variety of wounds depending on design and whether open or closed at the time of injury.
• Glassing (or bottling)—numerous incised wounds of varying shapes, sizes and depths. It may also cause a mixed type injury with features of both sharp force injury (from broken glass) and blunt force injury (from contact with the bottle before it breaks)
• Meat forks—abraded if the shaft is blunt, the distance between the two puncture sites may not correlate with measurements of the fork due to skin movement and the curvature of many skin surfaces.
• Screw driver—abraded edges due to skin being pulled down into the wound (the screw driver being relatively blunt)

Table 4.5 Comparative typical features of lacerations and incisions

Laceration	Incision
Wound margins may be: Ragged Crushed Abraded Inverted Bruised Foreign material may be found Bridging strands may be seen (undivided tissue that stretches across the wound)	Wound margins may be: Clean Regular Not crushed Usually not abraded Everted Usually not bruised

Transient Lesions

Redness and wheals are non-permanent, transient signs that might follow trauma.

Wheals, are caused by initial vasodilatation and local release of vasoactive peptides following an injury such as a slap, scratch, or punch, which will leave no mark after a few hours. The classic features of the triple reaction are present (redness, pain and swelling), but no specific damage is done to any tissues. Thus, reddening associated with pain with possible subsequent development of local swelling may be present initially—but after a few hours may have resolved, unlike bruising which will still be present 24 or more hours after it first appears. Reddening caused by vasodilation can be distinguished from bruising by applying finger pressure—bruises do not blanch on finger pressure. Such injuries are non-specific. Although it is important to record whether these features are present, it must be borne in mind that there may also be non-traumatic causes for these lesions (e.g. eczema/dermatitis, psoriasis, impetigo). Red marks outlining an apparent injury, for example, the imprint of a hand on the slapped face or buttock of a child, should be photographed immediately as such images may fade within an hour or so and leave no residual marks.

Size and Shape of the Injury

The size of an injury should always be recorded in centimetres (and if photographed a rule & color chart (ForensiGraph® - www.forensigraph.com) should be used). There are still three countries in the world, however, that continue to use the Imperial system (inches not centimeters): Liberia, Myanmar and the United States of America).The general shape of the wound should also be described; simple terms such as circular, triangular, V-shaped, or crescentic are useful, but if the wound shape is irregular or complex then it is possibly easier to record this feature on a body chart and a photo. Wounds also may have depth, but it is not always possible to determine wound depth accurately (or often, at all) in the living unless some other form of imaging (e.g. ultrasound, CT or MRI) modality was used. If the person who has sustained the injury is being operated on it should be possible for the operating surgeons to record direction and depth of penetration, if asked specifically, and if possible to take pre-operative images of the surface wounds. Alternatively, an HCP might ask permission of the surgeon (with patient consent) to be present in the operating theatre to assist with the taking of images.

Position of the Injury

Location of an injury is best done by relating it to fixed anatomic landmarks. On the head, one can use the eyes, ears, nose, and mouth, on the neck the prominence of the thyroid cartilage and the sternocleidomastoid muscles, and on the trunk the nipples, umbilicus, and bony prominences can be used as points of reference. The advantages of using simple anatomic diagrams and body charts for locating the injury are self-evident. It is a simple process to record the position of an injury accurately, yet when medical records are reviewed it is common to find little or no indication of precise site of injury.

Ageing Injuries

Identifying a specific time, or time frame, for the infliction of an injury is one of the most frequently asked and possibly least frequently satisfactorily answered questions in forensic practice. It is very important to manage the expectations of those asking the questions. For most unwitnessed injuries, it is not possible to precisely time or date when injuries were caused. Injuries inflicted shortly before examination (in both living and deceased) will show no clinical or pathological evidence of healing. The physiological healing process (whether of blunt or sharp force injury) depends on a number of variables including the site of injury, the force applied, the severity of tissue damage, infection, and previous treatment. These can all make assessment of the age of a wound difficult. Bruises often become more prominent some hours or even days after infliction because of diffusion of blood closer to the skin surface; on occasion, a recent deep bruise may be mistaken for an older, more superficial lesion.

Bruises resolve over a variable period ranging from days to weeks; the larger the bruise the longer it will take to disappear. The colors of a bruise can include (dependent on the examiner) blue, mauve, purple, brown, green, and yellow—and all tints and hues associated with these. Many bruises exhibit multiple colors. The key study [26] which looked prospectively at bruise evolution by color showed that a bruise with a bright yellow color was likely to be more than 18 h old (although the study relied on assessment from photographs and limited patient numbers). The ability of a person to accurately perceive the color yellow diminishes with age [27]. The colors red, blue, and purple/black can occur anytime within 1 h of bruising to resolution (up to 21 days in the study) [26].

Early appearance of a bruise depends on the escape of hemoglobin containing erythrocytes from blood vessels into the tissue and depth within the skin at which this occurs.

The presence of hemoglobin near the surface of the skin may appear red while it may appear blue deeper in the tissue. This is thought to be the result of "*Rayleigh scattering, absorption coefficients of the skin and interpretation by the visual system*" [28]. Once blood is released, neutrophils and then macrophages breakdown red blood cells, splitting hemoglobin into biliverdin (green pigment). Biliverdin is rapidly converted to bilirubin (yellow pigment). Release of carbon monoxide during this process may make bruises brighter red. This would indicate that coloration of bruises and the progress and change of color patterns cannot be used to time the injury.

Studies show that estimation of bruise age from color photographs is also imprecise and should not be relied upon—as the color values are not accurate [29]. This is supported by another study [30] which identified great inter-observer variability in color matching both in vivo and in photographic reproductions. Other

Table 4.6 Key points regarding ageing of injuries

Ageing is not precise and may be influenced by:
• Extent and nature of the injury
• Health of the individual
• Post-injury wound care and treatment
• Early changes may include bleeding, swelling
• Reddened margin, scab formation 12–24 h
• Granulation tissue 24–72 h
• 3 weeks onwards healing with scar formation

information (e.g. a witnessed blow) is the only way of reliably timing a bruise. Studies show that in children, no evidential value for aging of bruises should be put on color [31] and this principle realistically is also applicable to adults. Animal studies have shown that histological evaluation of two bruises from a pig with multiple lesions was found insufficient to assess the overall age of the lesions as substantial variation in the inflammatory response between bruises was present [32].

Abrasions sustained during life are usually red–brown in color and exude serum and blood, which harden to form a scab. This scab organizes over a few days, before detaching to leave a pink, often intact surface. This process may be modified by accidental knocking of scabs, picking, scratching at the scab site. In the absence of medical intervention, lacerations tend to heal with scarring, usually over a period of days or weeks, whereas incisions, the edges of which are often apposed, heal within a few days although some may scar badly (Table 4.6).

In providing a conclusion/opinion regarding injuries the Istanbul protocol hierarchy of consistency can be very useful in court [33]:

- **Not consistent**: could not have been caused by the trauma described;
- **Consistent with**: the lesion could have been caused by the trauma described but it is non-specific and there are many other possible causes;
- **Highly consistent**: the lesion could have been caused by the trauma described and there are few other possible causes;
- **Typical of**: this is an appearance that is usually found with this type of trauma; and.
- **Diagnostic of**: this appearance could not have been caused in any way other than that described.

Types of Injury

Bruises

Definition

Bruising is the visible evidence of leakage of blood into soft tissues as a result of injury to blood vessels. Ecchymosis and contusion are terms that have been used variously to describe different sizes of injury, but do not enhance understanding of either causation or mechanism of injury and should no longer be used—although contusion is still used frequently by clinicians to simply describe blood leakage from damaged blood vessels in internal organs such as the brain. Hematoma should be used to refer to a collection of liquid blood forming a fluctuant mass under the skin. The difference between that and a standard “bruise” is that a hematoma may be capable of being aspirated by needle—in the same way as a collection of pus from an abscess.

Bruising is caused when an impact damages blood vessels such that blood leaks into the perivascular tissues and is evident on the skin surface (or organ) as discoloration. In some cases, although blood vessels may be damaged, there may be no visible evidence on the skin. In certain cases, it may take hours or days for any bruise to become apparent (as the blood diffuses through damaged tissue, or along tissue planes). The blunt force ruptures small blood vessels beneath the intact skin, and blood then escapes to infiltrate the surrounding subcutaneous tissues under the pumping action of the heart (Fig. 4.2). Thus, theoretically at least, bruising is not produced after death. In fact, severe blows inflicted after death may cause some degree of bruising, although this is usually only slight. Bruises may be associated with other visible evidence of injury such as abrasions, lacerations and fractures, and these lesions may obscure the underlying bruise.

Bruises vary in severity according to the site and nature of the tissue struck, even when the force of the impact is the same. For example, a moderate blow may produce bruising associated with soft tissue swelling—for example a black eye. There are, however, other causes for black eyes, including a direct blow to the forehead or nose (even with no direct impact to the eye region itself) with blood from damaged scalp tracking down over the supraorbital ridge or a fracture of the base of the skull allowing blood to traverse the orbital roof manifesting itself as a black eye (see Fig. 4.3).

Bruises can enlarge and evolve (in terms of shape and position) over a variable period of time, affected by both movement and gravity, which can be misleading as to the actual site of original injury. Further difficulties arise if a bruise, as it extends, tracks along tissue planes from an invisible to a visible location. There are a number of other factors to consider in the forensic interpretation of bruises (see Table 4.7). Bruising of this kind may not become apparent externally for some time and then at a point some distance from the site of the original impact. This delay in the appearance of bruising is of considerable significance since absence of apparent injury at an initial examination is not necessarily inconsistent with bruising becoming apparent 24–48 h later. It is often advisable to conduct a further examination a day or so later and to get sequential photographs. A variety of photographic techniques have been used to try and enhance the visualization of bruises, or identify previous blunt force not visible to the naked eye, but none have a strong or compelling evidence base [34], with conventional and cross-polarized being superior to ultraviolet or infrared.

Also consider:

- Site of trauma (tissue vascularity, near to bone, type & texture of tissues)
- Condition of tissues (elderly, infants)
- Treatment post injury (reduce swelling with elevation)
- Time since alleged injury
- Skin pigmentation—darker skin may be difficult to see the entire bruise/pale skin more likely to see entire bruise

Many bruises (unless patterned or in groups) are nonspecific injuries, and it is usually not possible to offer any detailed opinions on the agent responsible. Some

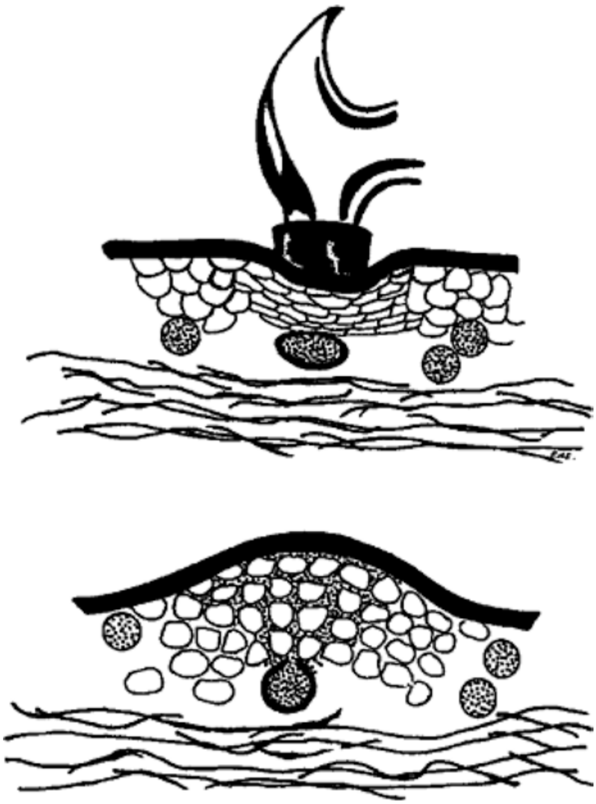


Fig. 4.2 Diagrammatic representation of how bruises are caused

bruises, however, may have a pattern (a patterned bruise), or because of their shape, size or location may have particular significance.

Types of patterned bruising:

Petechiae:	Small intradermal hemorrhages<3 mm diameter, that do not blanch with pressure. Often seen as part of a suction injury or strangulation but have been identified in over 70 reported medical conditions
Tramline:	Patterned bruising that occurs when an object impacts skin with sufficient intensity as to force blood out from the underlying blood vessels (at the site of impact) forming a bruise in the rough outline of the impacting object and either an area of sparing (non-bruising) on the skin centrally or bruising of a different color
Fingertip' bruises:	A collection of round/oval bruises, often 1—2 cm in size e.g. over the inner upper aspect of the arms and inner upper aspect of thighs. These may be suspicious of fingertip bruising which is generally caused by the pressure exerted from the fingers or thumb when grasping someone, prodding or poking with the fingers, or the firm impact of a knuckle. They may be seen on the limbs or on the abdomen when the victim is poked, prodded, or punched. Such injuries may also be seen after restraint, when an elderly person has been helped up by gripping the upper arms after a fall, or as a result of transporting a patient into an ambulance, for example. Questions often asked in courts include 'are these adult hands or fingers', and 'was the person left or right handed'. In general there is no possibility of being sure.

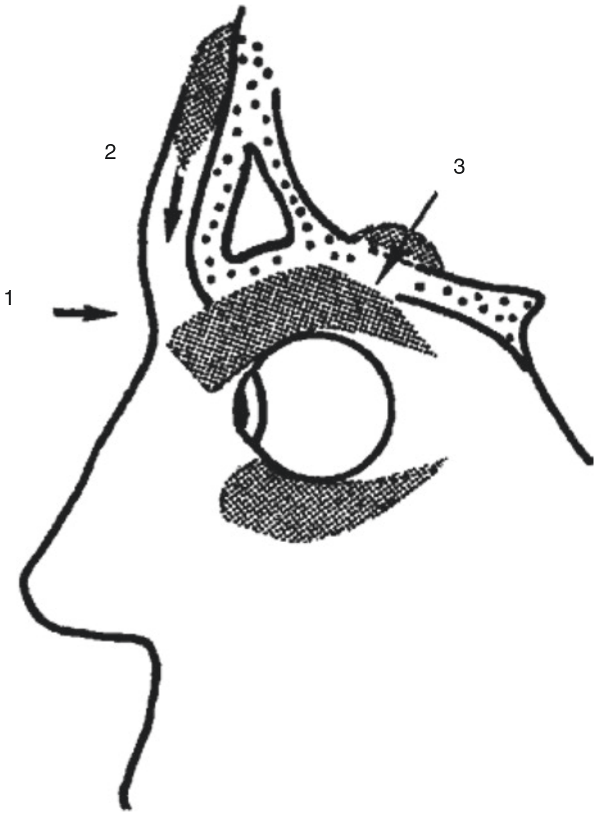


Fig. 4.3 Production of a black eye. (1) Direct blow to the orbit. (2) Injury to the front of the scalp. (3) Fracture of base of skull

Bite marks:	Typically present as a semi-circular injury which comprises two separate arcs (from upper and lower teeth) with a central area absent of injury or with a diffuse bruise present. It is not unusual to see only one arch and, if this is the case, it is usually the lower teeth. This is due to the mechanics of biting where the maxilla generally remains fixed while the mandible moves until the teeth meet. It should be noted that the "classic" bite mark is rare as the victim tends to try and pull away when it occurs.

Anatomical Location

Some bruises may have more significance by virtue of their anatomical location e.g. the neck, abdomen and buttock. Bruising at these sites is less common because the underlying bony structures are not in close proximity to the overlying skin. It would suggest, therefore, that a reasonable amount of force might have been needed to damage any blood vessels between the site of impact and the underlying bone. Accidental bruising that occurs over the inner upper thigh or inner upper arm

Table 4.7 Some factors to consider in the forensic interpretation of bruising

Cultural practices:	e.g. suction cups and from coining
Issues with clotting (hereditary):	e.g. Haemophilia, Von Willebrand's
Issues with clotting (acquired):	e.g. Idiopathic Thrombocytopenia, Malignancy, Vitamin K deficiency, alcohol (dependency)
Medications	e.g. Salicylate (Aspirin), Warfarin (anticoagulants), NSAIDs, steroids
Herbs	e.g. Gingko biloba, ginseng, glycosamine, turmeric, angelica, clove, large quantities of garlic, saw palmetto, willow bark which can thin the blood slightly
Diseases:	e.g. Liver disease, high blood pressure)
Connective Tissue Disorders:	e.g. Ehlers Danlos syndromes, Epidermolysis Bullosa
Hypersensitivity:	e.g. Phytophotodermatitis, Stevens Johnson syndrome
Increased valsalva or intra-abdominal pressure	e.g. coughing, vomiting
Dermatitis	e.g. Lichen sclerosis
Infection	e.g. DIC, Meningococcaemia
Others	e.g. Henoch Schönlein Purpura
Excessive exercise:	e.g. in athletes and weight lifters (due to microscopic tears in blood vessels)

is less common because of the relatively protected nature of these sites. For example, the inner upper arm is normally a relatively protected area making accidental injury less likely compared with the front, back and outer aspects of the upper arm which are more exposed. In children, non-accidental injuries (see Chap. 5) must be differentiated from bruises seen on toddlers and children associated with "normal" activities, play, or sports [31].

Abrasions

Definition

An abrasion is usually a superficial injury that occurs as the result of pressure and movement (see Fig. 4.4). If deep enough to exude serum, the injury is progressively covered by a scab. Abrasions may also bleed as occasionally they are deep enough to breach the vascular papillae that corrugate the undersurface of the epidermis in which case frank bleeding may be present at an early stage.

Brush/Scuff abrasion: Very superficial abrasion with barely any damage to the skin and little or no exudation of serum (and thus no or little scab formation).

Abrasions can be further sub-categorized in the following ways:

Linear abrasions: scratches, can be caused by fingernails across the surface of the skin or pointed non-cutting objects The finer the object (edge of paper as in a paper cut) or the sharper the point (e.g. a broken nail, knife tip, broken glass) the narrower the linear abrasion is likely to be. The latter can also be referred to as "point abrasions".

Graze/tangential abrasions: These are non-linear abrasions (where broader areas of skin have been involved). There may be some suggestion of direction of the object used to cause the abrasion (directional graze abrasion) or there may be no obvious direction (non-directional graze abrasion). Elevation of parts of the superficial epidermis to one end, may help differentiate the direction of travel of the opposing surface i.e. horizontal or verticalor it may be possible to infer that the victim had been dragged over a rough surface.

Crush abrasion: where the impact has been applied vertical to the skin, may see imprint of impacting object on surface of the skin. It may be patterned.

Consider the causation for each sub-category and the presence of possible evidence or soiling within the abrasion. Some abrasions may be contaminated with foreign material such as dirt or glass, which may have important medicolegal significance. Such material should be carefully preserved for subsequent forensic analysis. In such cases, consultation with a forensic scientist can ensure the best means of evidence collection and preservation (Fig. 4.4).

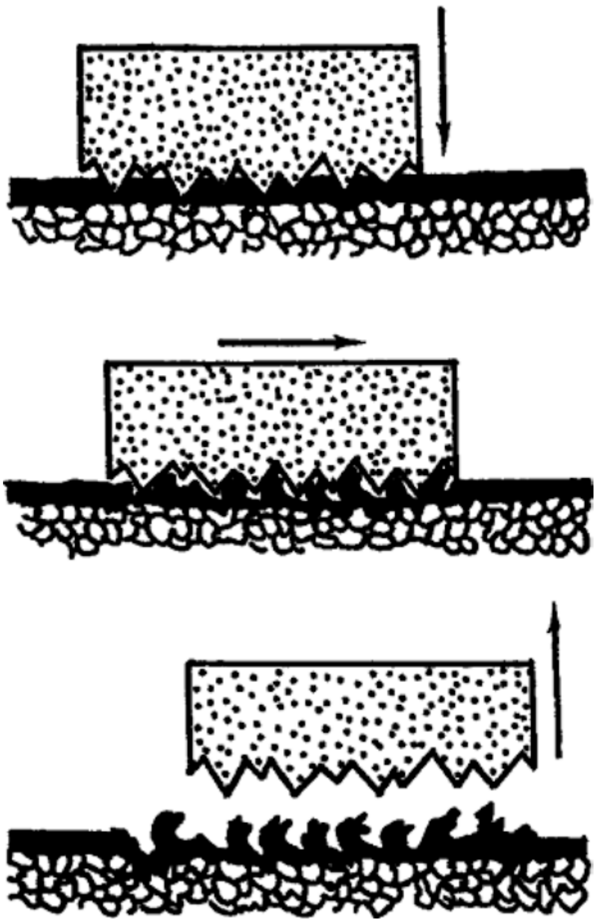


Fig. 4.4 Diagrammatic representation of the production of an abrasion

The patterning of abrasions is clearer than that of bruises because abrasions may record a clear impression of the shape of the object causing them and, once inflicted, do not extend or gravitate—therefore they indicate precisely the area of application of force.

Fingernail Scratches

A scratch from a nail will, if done with sufficient force, result in a linear abrasion. Linear regular scratches of similar depth in a converging pattern are typical of such injuries. They may be linear if the nail is dragged down the skin or short, straight or curved when the skin is gripped in a static fashion [35]. They may be the width of a nail across [36].

Some scratch marks cause wheals (redness and minor swelling that disappear within a few hours) while others can draw blood [36].

Lacerations

Definition

Lacerations can be caused in two ways:

Crush lacerations: these occur when the tissue (skin or organ) is compressed between two objects with sufficient force to cause the tissue to break. The site of injury is at the site where pressure was exerted. It is caused by blunt force which results in tearing to the full thickness of the skin (Fig. 4.5)—most frequently when the skin and soft tissues are crushed between an impacting object and underlying bone. A classic example is where a laceration occurs when a punch is thrown to the eye of a victim, where the bony orbit lies immediately beneath the skin. These lacerations can often mimic incised wounds (or vice-versa) particularly where the skin is closely applied to underlying bone, for example, the scalp. Close examination of the injury can normally resolve the issue. These injuries may have margins that are bruised or macerated. Blood vessels, nerves, and delicate tissue bridges may be exposed in the depth of the wound, which might be soiled by grit, paint fragments, or glass.

The shape of the laceration may give some indication as to the agent responsible.

Split lacerations: These occur where tissue is stretched at two points resulting in a “split” or “tear” at the weakest point in between. A classic example is the split laceration that might be seen at either the posterior fourchette or fossa navicularis following penetration by a blunt object e.g. penis, digit etc. These may not exhibit the classical characteristics seen with the crush lacerations (e.g. tissue bridging, contaminated wound or damaged wound edges).

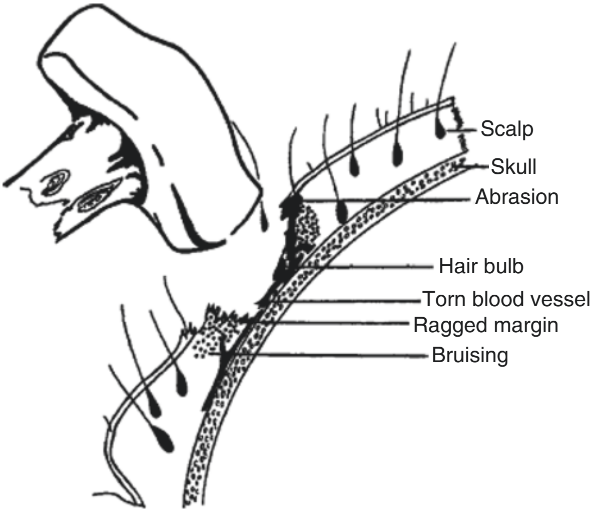


Fig. 4.5 Diagrammatic representation of the production of a laceration of the scalp

Incisions

Definition

Incised wounds are caused by sharp cutting implements, often bladed weapons such as knives and razors, but anything with a cutting edge such as shards of glass, edges of tin cans, and sharp tools such as chisels may also cause clean-cut incised injuries [37]. Injuries extend through the full thickness of the skin. Axes, machetes, Samurai swords, and other similar instruments, although capable of cutting, may causemixed type injuries(with characteristics of both sharp and blunt force injury)—as the injury caused by the weight of the instrument (e.g. axe head) may also cause blunt injury. Each element of the injury must be documented. Classical features of an incision (Fig. 4.6) include margins that tend to be clean, straight, unbruised, unabraded, and not inverted. The deeper tissues are all cut cleanly in the same plane. If the blade of the weapon is drawn across the skin while it is lax, it may cause a notched wound if the skin creases. Similar notching may occur if the sweep or direction of travel of the blade changes.

The head and neck are common targets when incised wounds are inflicted by an assailant. In an attempt to ward off the assailant, the arms are often raised in a protective gesture, and incisions are then often seen on the outer borders of the upper arms, forearms, and hand. If the blade of the attacking weapon is grasped, then incised wounds are apparent on the palmar surfaces of the fingers and can result in underlying damage to tendons, blood vessels and nerves. Such injuries are known as defense wounds. The palmar injuries often cannot be distinguished from wounds

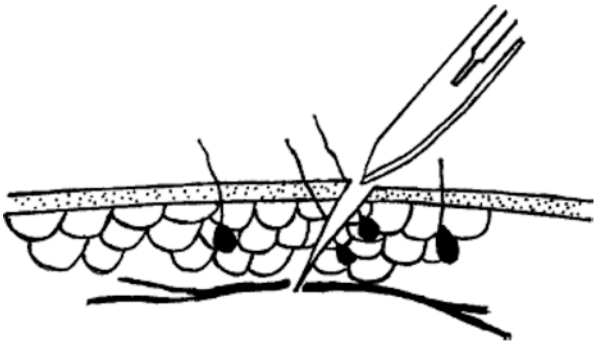


Fig. 4.6 Diagrammatic representation of a cross-section of an incision

caused when the hand of the assailant holding the blade slips down the blade from the handle, if the knife hits bone or cartilage.

Types of Incised Wounds

Stab wounds:

These are incisions where the depth is greater than their width or length.

Slash wounds:

These are incisions where the width/length is greater than the depth.

Puncture wounds:

These are penetrating injuries caused by sharp objects forced through the skin. Examples include needle stick injuries/injections/venipuncture.

Stab and slash incisions are often caused by knives, but can also be inflicted with glass shards, etc. If a penetrating wound occurs as a result of assault with a non-sharp item e.g. screwdrivers, pokers, scissors, the term "blunt force penetrating wound" is better applied. Perforation of the skin, in these cases, is less related to the sharpness of the implement than to the force that was used.

Although the external injury may not appear to be particularly serious, damage to internal organs such as the heart, liver, or major blood vessels can lead to considerable morbidity and death, usually from hemorrhage. In those cases that survive, it is common for little information to be present about the forensic description of the wound as the priority of resuscitation may mean that no record is made. If operative intervention is undertaken, the forensic significance of a wound may be obliterated:

(a) by suturing or
(b) using the wound as the entry for an exploratory operation or insertion of a drain (e.g. chest drain).

In such cases, it is appropriate to attempt to get a forensic physician to assess the wound in theater prior to treatment. Stab wounds are rarely accidental and occasionally suicidal, but usually their infliction is as a result of criminal intent. In the case of suicide, the wounds are usually located on the front of the chest or upper abdomen and, as with self-inflicted incisions, may be associated with a number of

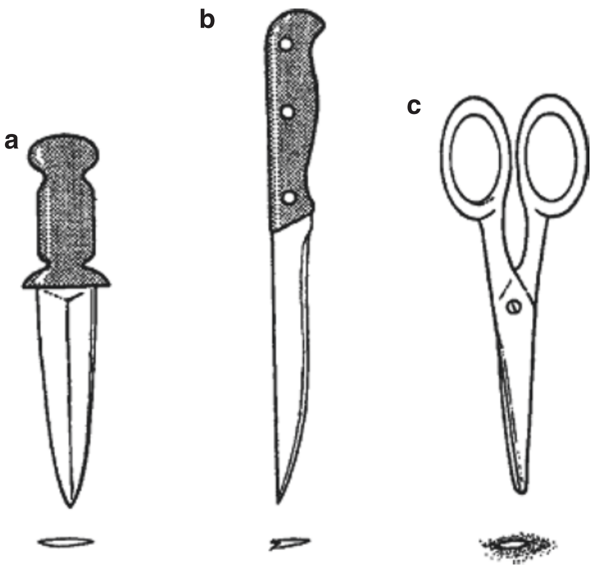


Fig. 4.7 Elliptical (**a**), fish-tailed (**b**), and bruised ovoid (**c**) stab wounds

superficial tentative puncture wounds. When deliberately inflicted by an assailant, they may be associated with defense injuries to the arms and hands.

The appearance of the skin wound will vary depending on the weapon used and can easily be distorted by movement of the surrounding skin. Typically, when inflicted with a knife, the wound is usually elliptical in shape as the natural elasticity of the skin causes its length to shrink. If the blade was double-edged, such as that of a dagger, the extremities of the wound tend to be equally pointed. A stab wound from a single-edged blade, such as a kitchen knife, will often have one extremity rounded, squared-off, or fish-tailed (caused by the noncutting back of the blade). Notched wounds may be caused by the blade of the weapon being partially withdrawn and then reintroduced into the wound or rotated during penetration.

When blunt weapons are used, for example, a pair of scissors, the wound tends to be more likely to be of mixed type, rounded or oval, with bruising and maceration of its margins (Fig. 4.7). Scissor wounds can sometimes have a pattern such as a cross-shape caused by the blade screws or rivets.

It is rarely possible from an inspection of the skin wound alone to comment usefully on the width of the blade since the skin retracts and the knife is unlikely to have been introduced and removed perfectly perpendicularly. The same applies when trying to assess healed stab wounds. Long skin wounds may be caused with quite narrow-width blades.

Self-Harm

Self-harm (or self-injurious behavior) refers to any attempt by an individual to harm themselves and can include self-injury, overdose, or self-hanging. When assessing injuries, it is important to understand which factors may indicate the possibility that an injury was caused by self-harm. Individuals injure themselves for a number of reasons which may include: mental health issues, secondary gain, attention seeking, to support an allegation of an offence having taken place, seeking retribution against an individual, the presence of significant intellectual delay or as a result of significant previous trauma [38].

Self-inflicted injuries have a number of characteristics, which are not diagnostic, but which together may give an indication of self-infliction. Table 4.8 lists characteristics of injury that may suggest self-infliction. Some or all of these characteristics may be present but it is important to reinforce that only some and rarely all will be present. The absence of a particular feature does not preclude self-infliction nor does the presence necessarily imply self-infliction.

Table 4.8 Some Characteristics of Injury Which May Suggest Self-infliction

Characteristic	Additional Comments
1. On an area of the body that the individual can access themselves	Sites less accessible e.g. the middle of the back are less likely
2. Superficial or minor injury	Although more severe injury may be caused—particularly in those with psychiatric disorder
3. If there is more than one cut they are of similar appearance, style, and orientation	Typically self-inflicted cutting injuries are more superficial, numerous and similar than those sustained in an assault from another—where the natural reaction of the injured person is to avoid repeated injury and to move away, if possible
4. If other types of injury (e.g. scratches, cigarette burns) are of similar appearance, style and orientation	As above—more than one similar injury should raise an index of suspicion as to the possibility of self-infliction
5. Multiple similar injuries	Raises a high index of suspicion as to the possibility of self-infliction
6. Parallel injuries	As above
7. Injuries grouped in a single anatomical region	As above
8. Injuries are grouped on the contralateral side to the patient's handedness	A right handed person will tend to harm themselves on the left hand side of the body
9. Tentative injuries	Smaller or lesser injuries grouped with the main injuries suggest the initial 'tentative' attempts at self-harm
10. Old healed scars in similar sites	May indicate previous attempts at self-harm
11. Scars of different ages in similar sites	May indicate repeated previous attempts at self-harm
12. Slow-healing injuries	Persistence of wounds that would otherwise have been expected to heal—in the absence of any other factors.
13. Psychiatric and related issues—such as eating disorders, drug and alcohol misuse	

Firearm Injuries

The examination of fatal firearm injuries should be left to an experienced forensic pathologist; however, it is not unusual in cases of nonfatal injuries for a hospital clinician or forensic physician to be asked to comment on the nature of the wound or wounds. As with all injuries within the forensic setting, it is essential in these nonfatal cases that the initial appearances of the injuries be accurately described and the wounds photographed. This is particularly important since subsequent surgical treatment may distort or completely obliterate the wound characteristics. Furthermore, any fragments, bullets, or pellets found within the wounds must be carefully removed and handed over to the appropriate authorities. Patterns and nature of firearm injuries are very specialized areas, although broad principles apply [39–42]. There are two main types of firearm, smooth bore and rifled.

Smooth Bore Weapons

Shotguns, which fire a large number of small projectiles, such as lead shot, are the commonest type of smooth bore weapons. They are commonly used in sporting and agricultural activities and may be either single- or double-barrel. The ammunition for these weapons consists of a plastic or cardboard cartridge case with a brass base containing a percussion cap. Inside the main part of the cartridge is a layer of propellant, plastic, felt, or cardboard wads and a mass of pellets (lead shot of variable size) (Fig. 4.8a). In addition to the pellets, the wads and/or cards may contribute to the appearance of the wounds and may be important in estimating range and possible direction.

Rifled Weapons

These are characterized by having parallel spiral projecting ridges (or lands) extending down the interior of the barrel from the breach to the muzzle. This rifling causes the projectile, in this case a bullet (Fig. 4.8b), to spin as it is ejected from the weapon and thus imparts gyroscopic stability along its flight path. The rifling also leaves characteristic scratches, rifling marks, unique to the weapon on the projectile surface. The three main types of rifled weapon are revolver, the pistol, and the rifle. The revolver, which tends to have a low muzzle velocity of the order of 150 m/s, is a short-barrel weapon with ammunition retained in a rotating metal drum which rotates and loads each time the trigger is activated and a shot fired. The spent cartridge case is retained within the cylinder after firing. In the self-loading pistol, the ammunition is retained in a clip which, after firing, results in the cartridge case being ejected from the weapon with a spring mechanism elevating the next bullet into the breach. Muzzle velocities of pistols are between 300 and 360 m/s. Rifles are long-barrel shoulder weapons capable of firing bullets with velocities up to 1500 m/s. Most military rifles are “automatic,” allowing the weapon to continue to fire while the trigger is depressed until the magazine is empty. They are thus capable of discharging multiple rounds within seconds.

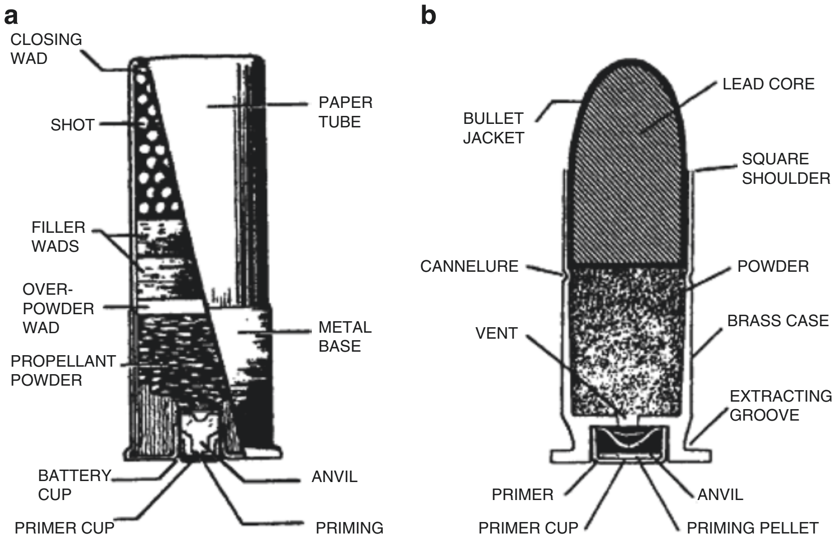


Fig. 4.8 Components of a shotgun cartridge (**a**) and a rifled bullet (**b**)

Shotgun Wounds

When a shotgun is discharged, the lead shot emerges from the muzzle as a solid mass and then progressively diverges into a cone shape, as the distance from the weapon increases. The pellets are often accompanied by particles of unburnt powder, flame, smoke, gases, wads, and cards, which may all affect the appearance of the entrance wound and are dependent on the range of fire. Both the estimated range and the site of the wound are crucial factors in determining whether the wound could have been self-inflicted.

If the wound has been sustained through clothing, then important residues may be found on this if it is submitted for forensic examination. It is absolutely essential that the advice of the forensic science team and crime scene investigator is sought when retrieving such evidence [43]. When clothing is being cut off in the hospital, staff should avoid cutting through any apparent holes.

Contact wounds are caused when the muzzle of the weapon is held against the skin. The entrance wound is usually a fairly neat circular hole, the margins of which may be bruised or abraded due to impact with the muzzle. In the case of a double-barrel weapons, the circular abraded imprint of the non-firing muzzle may be clearly seen adjacent to the contact wound. The wound margins and the tissues within the base of the wound are usually blackened by smoke and may show signs of burning due to the effect of flame. Because the gases from the discharge are forced into the wound, there may be subsidiary lacerations at the wound margin, giving it a stellate-like shape. This is seen particularly where the muzzle contact against the skin is tight and the skin is closely applied to underlying bone, such as in the scalp. Carbon monoxide contained within the gases may cause the surrounding skin and soft tissues to turn pink due to the formation of carboxyhemoglobin. Contact wounds to the head are particularly severe, usually with bursting ruptures of the scalp and face, multiple explosive fractures of the skull, and extrusion or partial extrusion of the underlying brain. Most contact wounds of the head are suicidal in nature (in the UK, Australia and New Zealand), with the temple, mouth, and under the chin being the sites of election. In these types of wounds, which are usually rapidly fatal, fragments of scalp, skull, and brain tissue may be dispersed over a wide area.

At close, noncontact range, with the muzzle up to about 15 cm (6 in.) from the skin, the entrance wound is still usually a single circular or oval hole with possible burning and blackening of its margins from flame, smoke, and unburned powder. Blackening due to smoke is rarely seen beyond about 20 cm; tattooing from powder usually only extends to about 1 m. The wads and cards rarely travel more than about 2 m.

As distance increases, the pellets begin to diverge. Up to about 1 m, they are still traveling as a compact mass, but between about 1–3 m the pellets start to scatter and cause variable numbers of individual satellite puncture wounds surrounding a larger central hole. At ranges greater than 8–10 m, there is no large central hole, only multiple small puncture wounds, giving the skin a peppered appearance.

Exit wounds are unusual with shotgun injuries as the shot is usually dispersed in the tissues. The pellets, however, may penetrate the neck or a limb, and in close-range wounds to the head, the whole cranium may be disrupted.

Rifled Weapon Wounds

Intact bullets penetrating the skin at 90° to the skin surface (orthogonal contact) usually cause neat round holes about 3–10 mm diameter. Close examination reveals that the wound margin is usually fairly smooth and regular and bordered by an even zone of creamy pink or pinkish red abrasion. A non-orthogonal nose-on strike is associated with an eccentric abrasion collar, widest at the side of the wound from which the bullet was directed (Fig. 4.9). Atypical entrance wounds are a feature of contact or near contact wounds to the head where the thick bone subjacent to the skin resists the entry of gases, which accumulate beneath the skin and cause

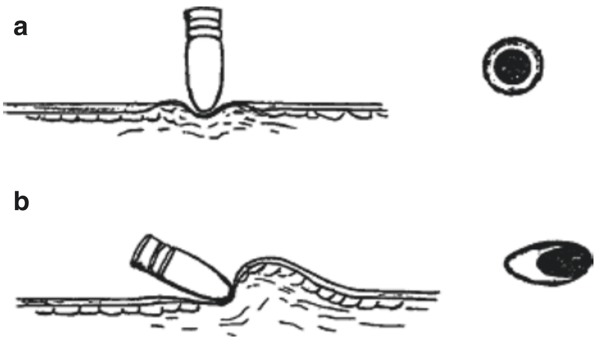


Fig. 4.9 Entrance wounds caused by perpendicular (**a**) and tangential (**b**) bullet strikes

subsidiary lacerations to the wound margins, imparting a stellate lacerated appearance. Contact wounds elsewhere may be bordered by the imprint of the muzzle and the abraded margin possibly charred and parchmented by flame. Punctate discharge abrasion and sooty soiling are usually absent from the skin surface, but the subcutaneous tissues within the depth of the wound are usually soiled. The effects of flame are rarely seen beyond 10 cm with sooty soiling extending to ~20 cm. Punctate discharge abrasions, which may be particularly heavy with old revolver ammunition, are often present at ranges up to ~50 cm. Sooty soiling of the skin surrounding a wound is evidence that is easily removed by vigorous cleaning carried out by medical or nursing staff. Also, the soiling of contact close-range entrance wounds may be absent if clothing or other material is interposed between the skin surface and the muzzle of the weapon. Clothing should always beretained.

Exit bullet wounds tend to be larger than entrance wounds and usually consist of irregular lacerations or lacerated holes with everted, un-abraded, and unbruised margins. When the skin at the site of an entrance wound has been supported by tight clothing, for example, eversion of the margins of the wound may be absent and the margins may even be abraded although irregularly, making differentiation between these and entrance wounds sometimes difficult.

Entrance wounds caused by damaged or fragmented bullets may be so atypical that it may not be possible to offer a useful opinion as to their nature. Also, it is inappropriate to offer an opinion on the caliber of a bullet based on the size of an entrance wound nor is it possible to state from the appearance of the wound whether the bullet was fired from a revolver, pistol, or rifle.

Defense Injuries

Certain types of injuries may be described as “defense” injuries. These are injuries that are typically seen when an individual has tried to defend themselves against an attack. These occur in both blunt and sharp force injuries and are natural reactions to assault. Some individuals, for example the very young and the very old, or those who are intoxicated, or already impaired by an assault, may be less capable of offering much defense against the perpetrators of assault.

When attacked with blunt objects, most individuals will attempt to protect eyes, head and neck by raising arms, flexing elbows, and covering these areas. As a result, the exposed surfaces of the arms become the impact point for blows. Thus, the extensor surface of the forearms (the ulnar side) may receive blows, the lateral/posterior aspects of the upper arm, and the dorsum of the hands. Similarly, the outer and posterior aspects of lower limbs and back may be injured as an individual rolls into a ball, with flexion of spine, knees, and hips to protect the anterior part of thebody.

In sharp blade attacks, the natural reaction may be to try and disarm the attacker—often by grabbing the knife blade. This can result in cuts to the palm and ulnar aspect of the hand. On some occasions, the hands or arms may be raised to protect the body against the stabbing motion resulting in stab wounds to the defense areas.

In blunt force attacks, the injuries sustained usually take the form of bruises if the victim is being punched or kicked, but there may also be abrasions and/or lacerations depending on the nature of any weapon used.

If the victim is lying on the ground while being assaulted, he or she will tend to curl up into a fetal position to protect the face and the front of the trunk, particularly from kicks. In these circumstances, defensive bruising is likely to be seen on other surfaces of the trunk and limbs.

The absence of defense injuries in persons otherwise apparently capable of defending themselves against an assault may be of particular significance if it is thought that other injuries found on the victim could have been self-inflicted or if it is believed that they were incapacitated through alcohol, drugs, or other injury.

Cruel Inhuman & Degrading Treatment and Torture

The World Medical Association's Declaration of Tokyo in 1975 defined torture as:

"The deliberate, systematic or wanton infliction of physical or mental suffering by one or more persons acting alone or on the orders of any authority, to force another person to yield information, to make a confession, or for any other reason."

The Declaration also laid down guidelines for doctors when faced with cases of suspected torture. The International Committee of the Red Cross definitions for torture and other forms of ill-treatment are [44]:

Torture consists of severe pain or suffering, whether physical or mental, inflicted for such purposes as obtaining information or a confession, exerting pressure, intimidation or humiliation; Cruel or inhuman (synonymous terms) treatment consists of acts which cause serious pain or suffering, whether physical or mental, or which constitute a serious outrage upon individual dignity. Unlike torture, these acts do not need to be committed for a specific purpose; Humiliating or degrading (synonymous terms) treatment consists of acts which cause real and serious humiliation or a serious outrage upon human dignity, and whose intensity is such that any reasonable person would feel outraged; Ill-treatment is not a legal term, but it covers all the above-mentioned acts.

The Manual on Effective Investigation and Documentation of Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (known as the "Istanbul Protocol") was the first set of international guidelines for documentation of torture and its consequences and was published in 1999 [33]. It is likely to be revised by 2020. The Istanbul Protocol describes all the processes to be followed when assessing allegations of torture. For most clinicians, torture is seen in two main contexts: first, that perpetrated by criminals and terrorist organizations, and second, that carried out, or allegedly carried out, by the police or other security force personnel during the detention and interrogation of prisoners and suspects. Non-judicial "justice" is now meted out worldwide in a number ofways. Methods used are fairly crude and barbaric. Fresh injuries or scars of previous injury may indicate previous restraint at wrists and ankles. All types of injury may be seen. Cigarette burns, which may be seen as discrete circular areas of reddish yellow, parchmented skin, are also quite common. Patterned injuries due to being struck with the butt of a gun or tramline bruising due to blows with a truncheon or baseball bat may be seen. In Northern Ireland, shooting through the lower limbs ("knee-capping") was a favored method of punishment by paramilitary organizations.

Systematic torture by security personnel, usually during interrogation of suspects, ranges from the subtle use of threats and intimidation to actual physical violence. Hooding, prolonged standing, and the use of high-pitched sound have all been used, as have attempts to disorientate prisoners by offering food at erratic times, frequent waking up after short intervals of sleep, and burning a light in the cell 24 h a day. Physical abuse includes beating of the soles of the feet, "falanga or falaka" which, although extremely painful and debilitating, may not cause any significant bruising. Adaptations of the use of water causing near drowning (waterboarding or submarino) may prove fatal if prolonged, as can the induction of partial asphyxia by enveloping the head in a plastic bag (dry submarino).

Electrical torture is well documented and carries the risk of local electric shocks as well as fatal electrocution. Repeated simultaneous slapping of the sides of the head by the open palms (telefono) may result in tympanic membrane rupture.

In all cases of suspected or alleged ill-treatment of prisoners, it is essential that the doctor or other HCP carry out a methodical and detailed "head to toe" examination [3, 4]. All injuries and marks must be accurately recorded and photographed and the appropriate authorities informed immediately. Increasingly, forensic physicians are involved in assessments of refugees and asylum seekers to establish whether accounts of torture (both physical and psychological) are true. This role continues to expand and the principles of independent assessment, documentation, and interpretation are, as with other areas discussed, absolutely vital in ensuring that courts and tribunals have the appropriate information to allow fair judgments to be reached. The Faculty of Forensic & Legal Medicine of the Royal College of Physicians has defined Quality Standards for healthcare professionals working with victims of torture [45].

Forensic Asphyxia

Definitions [46]

Asphyxia: All conditions caused by the failure of cells to receive or utilize oxygen
Suffocation: A broad term encompassing different types of asphyxia such as vitiated atmosphere and smothering, associated with deprivation of oxygen
Smothering: Asphyxia by obstruction of air passages above the epiglottis, including the nose, mouth and pharynx
Choking: Asphyxia by obstruction of the air passages below the epiglottis
Mechanical asphyxia: Asphyxia by restriction of respiratory movements, either by the position of the body or by external chest compression (includes positional asphyxia and traumatic asphyxia)
Positional or postural asphyxia: A type of asphyxia where the position of an individual compromises the ability to breathe

Traumatic asphyxia: A type of asphyxia caused by the external chest compression by a heavy object

Strangulation: Asphyxia by closure of blood vessels and / or air passages of the neck as a result of external pressure on the neck. Four main methods of strangulation:

1. Manual - the application of pressure to the neck using the hands - one or two hands may be held around the neck [47].
2. Chokehold or head lock—a restraining hold in which one person encircles the neck of another (usually within the crook of their arm) in a viselike grip, usually approaching them from behind. The amount of elbow flexion determines the amount of pressure applied to the neck. This is a known 'martial arts' grappling hold and is variably termed a sleeper hold or vascular/carotid restraint.
3. Ligature—A form of strangulation in which the pressure on the neck is applied by a constricting band tightened by force other than the body weight [45], e.g. a scarf or belt tightened around the neck.
4. Hanging - A form of strangulation in which the pressure on the neck is applied by a constricting band tightened by the gravitational weight of the body or part of the body. Examples include judicial hangings [48] (authority ordered hangings where a drop of 5–7 ft. or more is an integral part of the process) and non-judicial hangings.

There is increasing awareness of the dangers associated with strangulation. Its occurrence is common enough, especially amongst domestic partners or ex-partners, to possibly warrant asking all complainants whether or not they experienced strangulation (or had pressure placed to the neck area) as a part of the most recent assault. Injuries to the neck are not usually the result of accidental mechanisms and are more likely the result of infliction.

It takes greater pressure to occlude the windpipe (trachea) than it does the vessels of the neck (about 15kgs of pressure to occlude the trachea; 5kgs to occlude the carotid artery; and 1.8kgs to occlude the jugular vein) [49].

The jugular veins, on either side of the neck, are large vessels which return blood from the head to the heart. They have thinner walls than the carotid arteries, nearby, which send blood in the opposite direction, from the heart to the head. It is possible, therefore, for a given amount of applied neck compression that the veins may be occluded without totally occluding the arteries. In this case, blood continues to flow to the head and neck but is unable to leave, causing a build-up of pressure. It is not uncommon for victims of strangulation to observe this increase in pressure, telling examiners that they felt their head was about to explode or their eyes felt like they were going to pop out.

The build-up of pressure within the vasculature is the generally suggested cause of petechiae from strangulation. They may be seen over the face, eyes, soft palate and neck above the application of pressure. They may also be seen in the ear canal and be a reason for bleeding seen over the ear drum.

A similar mechanism is proposed for the development of subconjunctival hemorrhages. Other causes for these injuries include sneezing, coughing, straining/vomiting, eye rubbing, trauma, high blood pressure or bleeding disorder.

When another method of asphyxia (e.g. smothering or mechanical asphyxia) occurs at the same time asstrangulation, less pressure and time is needed required for strangulation to result in significant morbidity and death than when strangulation occurs in isolation.

Strangulation is considered a “red flag” for serious interpersonal violence [50], and is a significant predictor for future lethal violence [51]. It is a potentially life threatening event, as it may take little sustained pressure over a very short period of time to cause unconsciousness and death. It is common for there to be few or no physical signs on examination after fatal and non-fatal strangulation [52].

HCPs should be familiar with signs of strangulation and those signs that should prompt further investigation or extended observation periods. The Training Institute on Strangulation Prevention (https://www.strangulationtraininginstitute.com) provides access to numerous resources on the subject as well as information on training and upcoming webinars. Strangulation victims may require specialized radiological screening to exclude underlying injury.

Clinical assessment may reveal pain on swallowing, hoarseness, noisy breathing (stridor), neck, head or back pain. Physical examination may reveal the following [53]:

- no injury. In a study of 300 cases 50% of survivors of strangulation had no visible markings to the neck and 25% only minor injuries [54].
- tenderness
- transient reddening to the skin of the neck
- bruising and/or abrasions at the point of compression
- petechiae (pinpoint bruises) above the site of the compression in skin, eyes and mucous membranes e.g. lining of the mouth
- damage to the larynx, or thyroid cartilage, and or hyoid bone including fracture (frequently under-diagnosed) [55]
- linear abrasions on the neck from the assailant and victim, as the victim tries to take the assailant’s hand away
- damage to the mucosa of the mouth and tongue due to direct pressure on the teeth internally
- bleeding from mucosa where venous pressure is increased e.g. nose.
- subcutaneous emphysema (accumulation of air in skin tissue as a result of an increased intrathoracic pressure or rupture of the trachea)
- loss of laryngeal crepitus (the normal clicking sensation felt when the laryngeal cartilages are moved laterally. If there is no clicking it implies swelling between the laryngeal cartilage and vocal cords)
- restlessness or irritation
- carotid bruit
- limb weakness
- difficulty breathing

Bruises and abrasions may be seen on the front and sides of the neck, but the pattern of skin surface injuries may be difficult to interpret because of the dynamic nature of an assault and the possibility of the repeated re-application of pressure during strangulation.

In manual strangulation, small, crescentic abrasions, caused by the fingernails of the victim or assailant, may be the only signs visible on the neck. A victim resisting a sexual or other attack may claw at an assailant and leave linear parallel abrasions on the assailant's face [56].

Burns/Scalds [57]

A burn is an injury caused by exposure to thermal (heat/cold), chemical, electrical, or radiation energy. A scald is a burn caused by contact with a hot liquid or steam. Burn wounds are dynamic and need reassessment in the first 24–72 h because depth can increase as a result of inadequate treatment or superadded infection. Chemical burns are burns caused by acid, alkaline, or caustic chemicals and can be very damaging. Immediate first aid should be provided. If possible carefully remove the chemical and any contaminated clothing and rinse the affected area using as much clean water as possible.

Domestic Violence

Domestic Violence is clearly a global problem. Currently in the UK a statutory definition of domestic violence has been proposed in a draft Domestic Violence Bill [58]:

Behaviour by a person ("A") towards another person ("B") is "domestic abuse" if— (a) A and B are each aged 16 or over and are personally connected, and (b) the behavior is abusive.

Behaviour is "abusive" if it consists of any of the following— (a) physical or sexual abuse; (b) violent or threatening behavior; (c) controlling or coercive behavior; (d) economic abuse; (e) psychological, emotional or other abuse.

HCPs working in the environments of both general forensic and sexual offence medicine will see individuals, both male and female, who have been subjected to domestic violence. The general principles of history taking, examination, documentation and interpretation of injuries, treatment, and onward referral are all required. Safeguarding of adults, and of children, who may witness the violence is also essential. A proforma for the examination of adult complainants of domestic violence has been developed to assist HCPs in this role [59].

Currently the management of complainants/complainers of domestic violence is highly variable in different jurisdictions [60]. Complainants who have not been sexually assaulted may not be eligible to be examined at sexual assault centers. General practitioners (primary care physicians) and emergency department staff do not necessarily have the skills to document and interpret the injuries sustained and also have limited time to perform the assessments required. Historically in the UK forensic physicians performed this role but nowadays it would be rare for the police to ask the HCP to see a complainant of assault. There has been a promising initiative. The DV injury documentation project [61] in Western Sydney where complainants of domestic violence, aged 16 years or above, who had obvious injuries as a result of an assault by a partner or ex-partner, were eligible to visit the forensic medical unit and have their injuries documented. The results from this project showed that a forensic assessment increased the positive outcomes in court.

Bite Mark Injuries

Human bite marks occur in a minority of forensic medico-legal investigations, usually as a result of human beings biting one another. Occasionally, forensic bite marks have been reported in food and a miscellaneous group of inanimate materials. A bite mark has been defined as a mark caused by the teeth either alone or in combination with other mouth parts [62]. Human bite marks in skin are complex injuries and consequently the analysis is challenging. Bite mark analysis is the interpretation and comparison of two pieces of evidence, namely, the life-size, scaled photographs of the bite mark and the dental casts of the suspect biter.

Bite Mark Components

A human bite mark in skin is produced by three contributory components - dentition/mouth parts, skin and the episode of contact.

Dentition/Mouth Parts

A bite mark in skin is normally a representation of the maxillary and mandibular arches and the biting edges/cusps of teeth anterior to the second premolars. The dental arch features usually provide the information required to orientate the bite mark. The maxillary arch is normally larger and is composed of larger incisors and canines compared to the mandibular arch. There are many individual tooth features that are important in bite mark analysis; the presence or absence of a tooth, the location of the incisal angles of incisors and the cusps of canines. The character of the incisal edges and cusps may be affected by a variety of factors. The position or status of a tooth may be expressed as displacement and/or rotation. The interproximal embrasures are important distinguishing features between adjacent teeth.

The action of sucking produces a reduced intra-oral pressure that can traumatize the capillaries in the embouched tissue. The presence of a diffuse ovoid zone of bruising within the center of a bite mark is indicative of sucking activity [63]. Sucking may be accompanied by tongue thrusting, in which case, the appropriate descriptive term is suckling [64, 65].Tongue pressure marks are caused by a tongue thrusting action forcing the embouched tissue against the palatal and lingual surfaces of the anterior dentition and palate.

Skin

Skin is considered to be a poor impression medium because it is not dimensionally stable and is not capable of reproducing detail. There are a number of histological and physiological features that have a contributory influence; in particular, these relate to age and anatomical location.

Babies bruise easily; however, bruises in babies are sometimes difficult to see because of abundant subcutaneous fat. According to Gresham [66] bite marks in children are often faint and difficult to see. Important changes take place in the skin with ageing. The aged bruise easily due to poor collagen support of blood vessels and, consequently, slight pressure can produce an extensive bruise. It has been said that in contrast to infants and older people, teenagers and adults bruise less easily [64, 66], although there are no current data to support this (in the absence of medical reasons for such differences).

The contour or shape of the body varies depending on the anatomical location. In effect the quantity of tissue available for biting varies in different locations; the quantity of tissue is important because soft tissue absorbs and dissipates the kinetic energy of biting to a greater extent than hard tissue. Consequently, skin overlying soft tissue will be subjected to significantly lower levels of pressure than skin overlying hard tissue.

Bite marks usually occur in skin that is not covered by clothing. The presence of clothing at the time of biting reduces the degree of tooth pressure on the skin.

Episode of Contact

The dynamics of the action of human beings biting one another are complex. The degree of force and pressure exerted by the dentition on the skin can range from a minimal contact to a degree of holding of the tissue, to incision and avulsion of the tissue. The movement of the assailant and/or victim can range from static to extreme movement.

The nature of biting can range from amorous to aggressive with concomitant bite mark severity [62]. A "love bite" may occur during amorous contact; the mark is usually bruising caused by sucking and perhaps by gentle nibbling with the anterior teeth. The mark is characterized by diffuse bruising in the center; individual tooth marks are not a feature. By contrast, an aggressive bite mark is inflicted with the intention of causing pain. The marks relate mostly to teeth; the tooth marks usually form an ellipse leaving a central area relatively unmarked; alternatively, the tooth marks constitute scrape marks (abrasions) due to movement between the teeth and skin.

Nature of Bite Marks

The shape of a single bite mark is usually oval or almost circular. Occasionally, multiple bite marks are superimposed on one another which results in variations in the shape of the overall mark.

The injuries in skin are caused by the surface anatomy of the teeth, the biting edge or cusp produces crush injuries. The angle between the biting surface and the long-axial surface causes damage due to marked flexion and extension of the skin as it is sharply deformed round the angle. The interproximal embrasure produces petechial hemorrhages due to skin stretching across the embrasure or skin being forced into the embrasure. Due to its elastic nature, skin is capable of absorbing considerable kinetic energy prior to the level of pressure required to produce visible injury [63]. At the time of injury, particular tooth mark indentations will be present; however, the passage of time results in a smoothing out of the tooth indentations due to the visco-elastic nature of skin and its ability to reconstitute to its original contour.

The degree and type of tissue injury is determined by the severity of the bite that can range from a minor contact to extreme clenching of the tissue; consequently, the bite mark can range from mild bruising to avulsion of the bitten tissue [62, 63, 67]. In addition, there are a number of systemic factors that influence the response of skin to injury.

Bite marks in skin are composed of one or more of the following injuries, bruise, abrasion and laceration [63, 66]. Gravity may cause a bruise to change position. When a sharp incisal edge or cusp scrapes across the surface of skin, the movement may produce heaping of the epidermis at the point in the abrasion where the tooth movement stops. Lacerations are often accompanied by bruising and abrasion of the wound edges. The appearance of bite marks in living and dead subjects alters with time. Consequently, photography should be repeated, which could be daily, until the mark fades.

Incidence of Bite Marks

Bite marks occur in a variety of violent crimes, assault, rape, murder and child abuse. Bite marks are found on all anatomical sites. Consequently, when one bite mark is discovered, a complete body examination of the victim should be conducted. The morbidity associated with significant bites is well recognized [68, 69]. The circumstances of biting are variable in adults. The usual occurrence is the assailant biting the victim; the victim biting the assailant occurs infrequently. Rarely the victim has a self-inflicted bite mark. The circumstances of biting are less variable in children. The abuser is usually the biter [70, 71]. The occurrence of children biting other children during play has to be recognized as an innocent bite mark.

Bite marks on the victim and/or the assailant have been caused by either the other party, self or a third party. Consequently, the practical application is to examine all suspect dentitions in the relevant time-line of a bite mark case. In the case of a suspected self-inflicted bite mark, the anatomical location is the significant consideration - is it physically possible for the bite mark to have been self-inflicted?

Distortion in Bite Marks

Distortion can occur at different stages in the causation and investigation of bite marks. Primary distortion occurs at the time of biting and secondary distortion may occur subsequent to a bite mark being made and/or be introduced at the stage when it is being examined or recorded [72]. A bite mark may demonstrate more than one type of distortion. Some degree of distortion is probably present in all bite marks and may be produced by a variety of factors [70, 73–75].

Primary Distortion

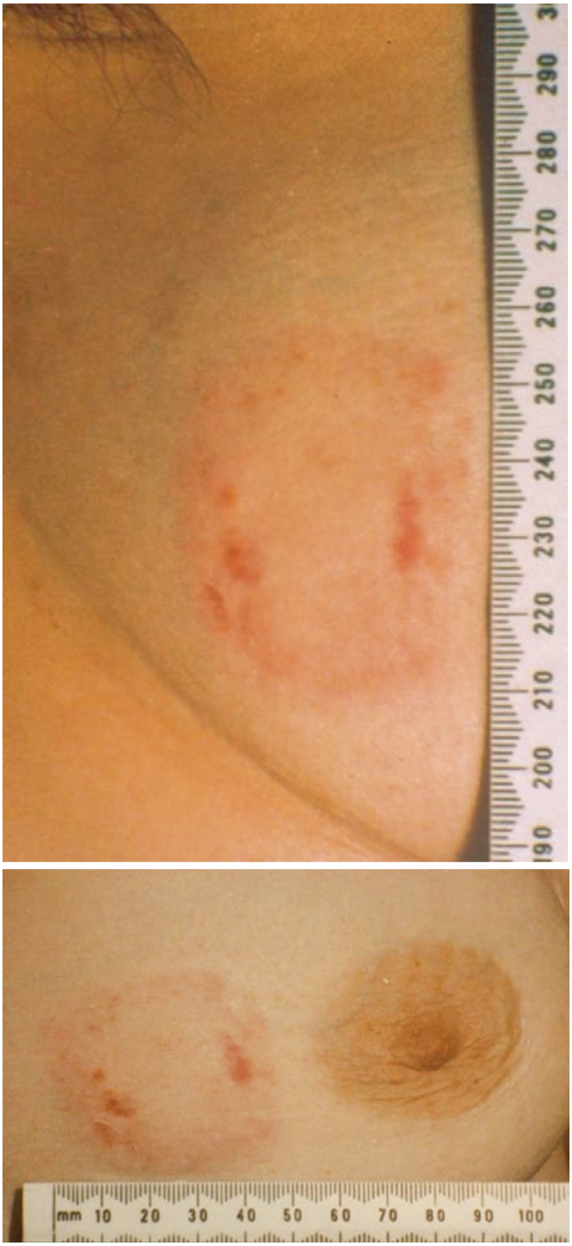
The two main components of primary distortion are dynamic distortion due to the dynamics of the biting process and tissue distortion due to the nature of skin [72]. Dynamic and tissue distortion are complex and unpredictable phenomena that are closely related because of their simultaneous occurrence during the episode of contact between the dentition and skin.

Secondary Distortion

There are three categories of secondary distortion [72]. Time-related distortion occurs when a bite mark changes in appearance with the time elapsed subsequent to the bite being made. The other two categories of secondary distortion, posture distortion and photographic distortion, occur during the examination and evidence recording of a bite mark.

Time-related distortion in living victims can take different forms. Where there is a laceration or where a segment of tissue has been bitten off, the subsequent healing can involve changes, particularly tissue contraction, that can modify the dimensions and detail of a bite mark. In a bruise, the changes with time can result in migration of part of the bruise to a slightly different anatomical location. The bruise may also diffuse variably giving an altered shape.

Posture distortion occurs when a bite mark is viewed or recorded in a position that is different from the position of the anatomical location at the time of biting. The degree of posture distortion depends on the variation in body position and the anatomical location, for example, posture distortion may be observed in the female breast depending on the body position and arm position as illustrated in Figs. 4.10 and 4.11. Posture distortion may be limited during photography by reconstructing a victim's body position at the time of biting; if this is not possible, it is suggested that bite marks are photographed in a range of positional possibilities [76].



Figs. 4.10 and 4.11 Posture distortion in a bite mark on the right breast photographed on successive days with the right arm raised to an unknown position on day 1 (Fig. 4.10) and the arm down by the victim's right side on day 2 (Fig. 4.11). The Police photographer was not supervised by an odontologist. The photographs demonstrate posture distortion that produced a significant variation in the size and shape of the bite mark; the variation measures approximately 25% in the vertical axis and 12.5% in the horizontal axis

Photographic distortion may be produced by the photographic method of recording a bite mark [77]. Photographic distortion arises as a result of the influence of the angle of the film to the bite mark and body curvature. The ideal photographic angle is 90 degrees, the camera being perpendicular to the center of the bite mark [74].

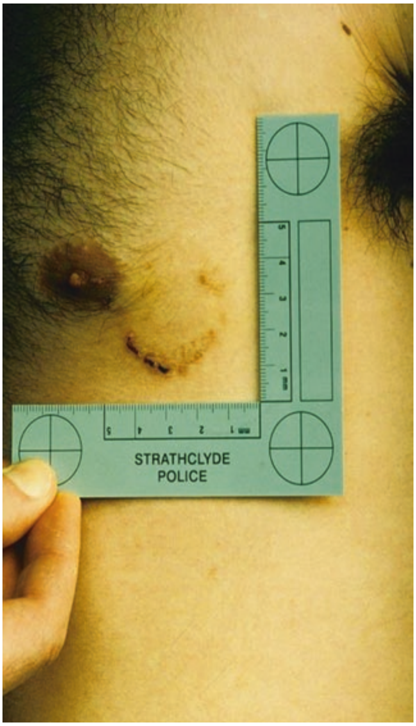


Fig. 4.12 The odontologist holds the ABFO No. 2 type scale adjacent to the bite mark; the planes of the scale and bite mark must be parallel and coincident.

This angle produces parallelism between the film/digital plane and the bite mark plane and consequently photographic distortion is minimized. The examining odontologist determines the position of the rigid, right-angled scale, similar to the ABFO No.2 scale [78] and holds the scale adjacent to the bite mark; the plane of the scale should be parallel to the bite mark plane and the two planes coincident as demonstrated in Fig. 4.12. If the curvature of the anatomical location prevents a single view of the entire bite mark, then the surface angle is large enough to cause significant photographic distortion and multiple scaled photographs, taken perpendicularly to the center of the various parts of the bite mark, are required. This technique limits photographic distortion as illustrated in Figs. 4.13, 4.14 and 4.15.

Bite Mark Analysis Techniques

Biological Comparison

Sweet et al. [79] pioneered the work on the recovery of salivary DNA from bite marks. The techniques are objective and offer a scientifically validated method of bite mark analysis. However, the techniques are expensive and require extensive

Fig. 4.13 General photograph showing the location of a bite mark on the opposing surfaces of the child's left forearm. The entire bite mark cannot be viewed from a single direction; to avoid photographic distortion, the opposing surfaces of the forearm were photographed separately

Fig. 4.14 Scaled photograph of the arc of marks on the posterior surface of the left forearm taken under the supervision of an odontologist

laboratory equipment and expertise; it should also be noted that DNA can become degraded and is susceptible to environmental factors.

Physical Comparison

Bite mark analysis is the interpretation and comparison of the life-size photographs of a bite mark with the dental casts of a suspect biter. The comparison process

Fig. 4.15 Scaled photograph of the arc of marks on the anterior surface of the left forearm taken under the supervision of an odontologist

consists of two physical comparison techniques, feature based analysis and superimposition based analysis.

Context Effects and Observer Bias

According to Page et al. [80] context effects are psychological influences on decision making induced by knowledge of extraneous circumstantial information; cognitive bias refers to the psychological sway toward one opinion versus another due to having extraneous information. Context effects give rise to motivational bias and may also give rise to cognitive bias, particularly when there is ambiguity in the choice between two alternative hypotheses. Consequently, odontologists are susceptible to motivational and cognitive bias because of having circumstantial case information and the nature of bite mark evidence respectively. Clearly, context effects can be reduced by limiting the circumstantial case information available to the analyzing odontologist prior to bite mark analysis. Page suggested different odontologists collect and analyze the bite mark evidence to further reduce context effects and observer bias in the analyzing odontologist.

Feature Based Analysis

Feature based analysis demonstrates comparability/incomparability between the features observed in the photographs of the bite mark and the teeth of the suspect biter. Feature based analysis comprises a number of stages that are conducted in a prescribed sequence; examination of the bite mark photographs, preparation of a predictor of the causal dentition, examination of the dental casts of the suspect biter, comparative study and finally conclusions.

Superimposition Based Analysis

Superimposition based analysis demonstrates comparability/incomparability between the images of the bite mark and the teeth of the suspect biter. The role of superimposition based analysis is to provide visual comparability/incomparability between the life-size, scaled photographs of the bite mark and life-size, computer-generated scaled transparent overlays of the suspect biter's dental casts.

Limitations of Bite Mark Analysis

Aitken and MacDonald [81] noted that classified bite mark characteristics on large sections of the population were unavailable; this statement remains true today. At present, the scientific literature and published research evidence relating to bite mark analysis lacks peer-reviewed publications supporting its current use, including data on error rates and reliability. The current efficacy of bite mark analysis should rely on the available scientific evidence and limit expert opinions accordingly.

There have been many judicial concerns in the USA about the evidential weight and analysis of human bite marks following miscarriages of justice associated with flawed analysis. Consequently, the American Board of Forensic Odontology and other groups have raised the forensic threshold for stating that injuries are bite marks and for the levels of conclusion that can be reliably stated following the comparison of an alleged/suspected human bite mark with the dentition of a suspect biter. An extract of the revised (19-2-2018) ABFO Guidelines is under noted for reference.

American Board of Forensic Odontology Standards and Guidelines for Evaluating Bitemarks - Extract

Terms indicating a pattern or patterned injury is or is not a bitemark.

1. *Human Bitemark*—human teeth caused the pattern
   Criteria:
   (a) The pattern demonstrates class characteristics of human teeth, including prosthetic replacements when present.
   (b) The discernible features are sufficient such that other causes for the pattern were considered unlikely or excluded.
   (c) A curvilinear pattern or patterned injury generally circular or oval and often consisting of two opposing arches that may or may not be separated at their bases by unmarked space. Sometimes only one arch is clearly visible.
   (d) Individual marks, impressions, abrasions, contusions, striations, or lacerations from specific teeth may be found within the pattern.
   (e) A central area of contusion is sometimes present.

(f) In severe human bitemarks, material may be forcefully removed from the medium bitten.
(g) The marks present reflect the size, shape, arrangement, and distribution of the contacting surfaces of teeth. (The contacting surfaces of human teeth include the incisal and occlusal surfaces of teeth and may also include the lingual surfaces of anterior teeth.)
(h) Some marks made by individual teeth can be recognized and identified based on the class characteristics and location relative to other features.
(i) The size and shape of each visible arch conforms to the varying ranges of size and shape of the human dentition.

2. *Not a Human Bitemark*—human teeth did not cause the pattern.
   Criteria: The pattern or patterned injury does not include features demonstrating the class characteristics of human teeth.
3. *Inconclusive*—there is insufficient information available to support a conclusion of whether or not a pattern or patterned injury is a human bitemark.
   Criteria: Features demonstrating the class characteristics of human teeth are incomplete, distorted, or otherwise insufficient.
   Terms relating or linking a dentition to a human bitemark

1. *Excluded as Having Made the Bitemark*
   Criteria: The bitemark demonstrates class characteristics or individual characteristics that could not have been caused by the dentition.
2. *Not Excluded as Having Made the Bitemark*
   Criteria: The bitemark demonstrates class characteristics or class and individual characteristics that could have been caused by the dentition. There are no unexplainable discrepancies between the features of the bitemark and the dentition. The dentition is not excluded from the population of dentitions that could have caused the bitemark.
3. *Inconclusive*
   Criteria: There is insufficient information to support a conclusion whether or not the bitemark could have been caused by the dentition.

Summary

The role of the HCP [82] in relation to the assessment of bite mark injuries is to remember that bites may result in bruising, abrasions, lacerations, punctures and even avulsions. The distinctive arc-shaped bruises with central sparing may not be seen because of distortion. The clinical management is important as referral to hospital may be required for treatment including tetanus, hepatitis B and HIV prophylaxis. The wound will need cleaning and antibiotics. Bite marks are of forensic importance as they may identify the suspect from certain dental features, as outlined above; a forensic odontologist, if available, should be contacted or careful documentation completed with measurements and scaled photographs. Furthermore, a skin swab utilizing the double-swabbing technique should be taken for DNA analysis.

Key Points

- Healthcare professionals working in the forensic environment must be able to describe injuries accurately, documenting what they see on examination in the clinical notes, and where appropriate, using body diagrams.
- Forensic imaging is a useful tool to document clinical findings, and in particular injuries, but there must be appropriate consent from the patient, with policies and protocols in place to cover the management of the images obtained.

Self-Assessment Exercises

1. You are in court to give evidence regarding an allegation of assault. The lawyers ask you to explain the injuries you found on examination to the jury:
    - What is a bruise?
    - What is an abrasion?
    - What is a laceration?
    - What is an incised wound?
2. A police officer has been bitten by a suspect. Outline your management.
3. A complainant of sexual assault advises you, the examining healthcare professional, that she was grabbed round the neck during the assault. What injuries may you find on clinical assessment?
4. What is the Istanbul protocol? How may it be used in providing an opinion with regard to the causation of trauma?

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Physical Child Abuse

5

John A. M. Gall

Learning Objectives
Understand the main presenting injuries of physical child abuse, their assessment and the conditions that mimic these injuries.

Understand the features and management of factitious illnesses related to physical child abuse.

Introduction

Physical abuse of children is common and carries a significant morbidity and mortality. Its consequences on the child are both short- and long-term and, for some, may be fatal. All professionals have an important role in recognizing suspected child physical abuse and making an appropriate referral but none moreso than child health practitioners, particularly general practitioners, paediatricians, and maternal and child health nurses. Unfortunately, the detection of this form of abuse remains challenging. As with any clinical presentation, a differential diagnosis is essential in formulating a final working diagnosis and, for children presenting with injuries, abuse must always be part of that differential. A failure to consider abuse as a

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potential cause of the injury or injuries will result in a potential missed diagnosis of abuse and a gross diservice to the patient. This chapter provides an overview of physical abuse in children as guidance to assist clinicians with their assessment of the potential cause of presenting injuries.

Definitions

For the purposes of this chapter, children are defined as a person below the age of 18 years [1]. This definition, however, varies between jurisdictions. In Western societies, physical abuse is recognized as one of four categories of child maltreatment with the other three being sexual abuse, emotional abuse, and neglect. It is well accepted that these categories may coexist in the same child or young person. Physical child abuse is an act of commission, both deliberate and intentional, although the intended consequence to the child may not be planned. For example, a carer may hit a child as a punishment but not intend to cause a serious injury [2]; nevertheless, such an act may cause significant physical and emotional harm and amounts to maltreatment. The UK Children Act 2004 [3] states that “physical abuse may involve hitting, shaking, throwing, poisoning, burning or scalding, drowning, suffocating or otherwise causing physical harm to a child. Physical harm may also be caused when a parent or carer fabricates the symptoms of or deliberately induces illness in a child.” Although each state in the United States is responsible for providing its own definition of child abuse and neglect, this description broadly encapsulates an internationally agreed definition of physical abuse. Debate continues, however, in some circles, around the influence and attitudes of societies, cultural differences in child rearing, politics, and religious beliefs on what constitutes child abuse.

A unified definition is important to inform a general framework for child protection policy setting, multi-agency assessment, statutory and legal interventions, epidemiology, and an understanding of current and future research.

Epidemiology

The true prevalence of physical child abuse is difficult to determine. The number of cases that are recognized by statutory child protection agencies is the tip of a much bigger iceberg of victims who never come to their attention. Many cases go unreported or unrecognized. Information systems are incomplete or record a limited part of the picture. Alternatively, estimates are on the basis of self reporting from victims or surveys of adults about their childhood experiences. A recent review of all available data concludes that between 4% and 16% of children are physically abused every year in high-income countries [4, 5]. Many of these children are victims of repeated episodes of abuse which start in early childhood.

Table 5.1 Risk factors for child abuse

Family factors	Parent/guardian factors	Child factors	Community and social factors
• Large families • Poor socio-economic status • Social isolation • Intimate partner violence/ domestic violence	• Young parents • The presence of a mental illness in one or both parents • Single parents • Unplanned pregnancy • Poor parenting skills • A history of maltreatment as a child • Substance abuse • Presence of a step-father • Known maltreatment of animals • Low educational achievement	• Being male • Emotional and behavioral problems • Being born premature • Born with a disability • Being an unwanted pregnancy being an adopted child	• No child protection/ safeguarding legislation • Unenforced child protection/ safeguarding legislation • Social inequality • Organised violence • Cultural norms

Risk Factors for Abuse

An important consideration in detecting child abuse is an understanding of the risk factors for abuse. These include family, parental (including non-parental guardian care giver), child, community and social factors [4, 6–9]. A list of these factors is provided in Table 5.1. The way that these factors interact to increase risk is complex and ill understood. It also needs to be kept in mind that the causal relationship between individual and associated factors is not inevitable as some households burdened with a number of risk factors develop resilience and are not abusive households.

Consequences of Physical Abuse

Physical abuse carries a significant mortality and morbidity. Child homicide figures reflect the most severe cases of physical child abuse. In the United Kingdom, between one and two children die from child abuse every week, while US child abuse mortality figures are as high as 2.35/100,000 annually [10]. The most serious abusive injuries include abusive head trauma (AHT) and visceral injuries. Both occur in the youngest children and have an estimated mortality rate of 12–30% [11, 12].

Significant neurological disability is seen in around half of the survivors of AHT [11] and many victims of abusive thermal injury sustain serious scarring and disfigurement. In terms of psychological outcome from physical abuse, it is difficult to disentangle the effects of associated types of abuse such as neglect and emotional abuse. However, studies confirm emotional and behavioral problems, post traumatic stress disorder, mental health problems, substance misuse, and criminality in survivors of abuse [4]. Early identification of physical abuse and early intervention are essential to prevent ongoing abuse and avoid its consequences.

Signs of Child Physical Abuse

The possible diagnosis of physical abuse should be at the forefront of any assessment of physical injury especially when the incident is either reportedly unwitnessed or where the injuries do not fit the history provided. Physical abuse may occur in combination with one or more of sexual abuse, emotional abuse and neglect. The nature of injuries sustained may include one or more of the following types:

- bruising
- abrasions
- lacerations
- bites
- burns and scalds
- skeletal injury
- abusive head trauma
- visceral injury

These injury types are discussed further below (and see Chap. 4).

Assessing a Child with Suspected Physical Abuse

Any clinician, indeed anyone who sees children on a regular basis, has a responsibility to recognize and report suspected physical abuse to statutory child protection (safeguarding) agencies, should these agencies exist. Who then should undertake the assessment of a child with suspected physical abuse? In most developed countries including the UK and USA, children with suspected physical abuse are referred to pediatricians to assess and investigate the child, to manage the injuries and determine the likelihood that the injuries are abusive or not. Experience shows that this is not necessarily ideal as many of these paediatricians do not have further training in forensic medicine and do not understand the many facets and intricacies of the discipline of clinical forensic medicine. The most appropriate practitioner, therefore, to undertake these assessments is either a paediatrician who has undertaken further formal training in clinical forensic medicine or a forensic physician who has extensive experience with children. Whichever of these two forensic practitioners is involved, and for the purposes of the remainder of this chapter they will be referred to as the ‘physician’, this physician should not be the practitioner providing care to the child but a completely separate and independent medical investigator. The reason for separating the treating physician from the investigating physician is that the treating physician needs to maintain good patient and parent interactions to ensure optimal health outcomes whereas the investigating physician may come to be viewed less than favourably by the parents/guardians. The investigating physician usually undertakes his/her assessment as part of a multidisciplinary team that may consist of other paediatricians, radiologists, haematologists, surgeons, nurses and social workers. This team may be involved in developing consensus decisions about the probability of abuse and the ongoing risk to the child. It is normally the practice that the investigating physician provides a medico-legal report and may then become involved in the legal child protection process and be expected to give an opinion in Court as a professional or expert medical witness.

When assessing an injury or injuries in a preadolescent child, there are two principal questions that the examining physician needs to consider and these are whether the injury is the result of accidental or nonaccidental causes. Consideration, therefore, needs to be given as to whether the explanation for the injury fits the account as provided by the parent or guardian and whether the injury is possible in the child based upon their age and developmental stage. If the injury is incompatible with either the account or the child's age and developmental stage then physical abuse becomes the working diagnosis until proven otherwise. In the absence of witnessed or admitted child abuse, a diagnosis of physical abuse can only be made on the balance of probability as there is no gold standard diagnostic test for the condition. The same considerations need to be made for the assessment of adolescents presenting with injuries. Generally unlike preadolescent presentations, a third consideration in the assessment that may arise is whether the injury sustained may be the result of self infliction.

As part of the assessment, a thorough history of the events and circumstances that led to the injuries that the child has sustained needs to be obtained. This information may be provided by third parties including preschool and school staff. Clear documentation of all relevant details is essential as these may have a bearing on the future protection of the child and decisions in any legal proceedings. It is widely accepted that certain features in a history raise concerns about physical abuse [13]. These include significant injuries where the cause is unexplained, or where the explanation is vague or detail is lacking or inconsistent; injuries that are inconsistent with the explanation given or where the explanation is inconsistent with a child's level of motor development. To make decisions regarding the plausibility of an explanation, it is important to know when or where the injury was sustained and details of the nature of the causative event; for example, if a fall is the proposed mechanism of injury it is essential to know the height of the fall, what the child was doing at the time, the nature of the surface of impact, and the anatomical site of impact. These details must be collected, in the context of the social, family, health, behavioral and developmental history of the child, to gain information regarding associated risk factors and to assess findings within a comprehensive family context.

The forensic assessment should include a full evaluation of the child's general physical, developmental, emotional, and behavioral welfare as well as a detailed assessment of the injuries that the child has sustained. This requires a clinical approach to determine the severity of injury and need for treatment, together with a forensic assessment of the pattern of injury in the context of the proposed explanation, to determine the likelihood of child abuse. A thorough evaluation of the child is required including investigations to identify the full profile of associated injuries and to exclude mimickers of abuse. The abuse may involve other siblings and family members who should be included in the assessment. Infants and young children are at the greatest risk of serious physical injury and are the most challenging to assess because of the sometimes occult nature of their injury and their inability to contribute to the history of the preceding events themselves. Although infants and very young children may not be able to provide details of abuse, studies have shown that additional useful information can be obtained from children including preschool children [14].

Cases of suspected physical abuse may be referred for assessment from a number of different sources including social services or child protection teams who have been alerted to the children following concerns expressed by members of the public, teachers, or health workers. Referrals may be received from general practitioners and from the emergency departments or inpatient units for a specialist opinion when clinicians raise concerns about unexplained or suspicious injuries.

Bruises

Bruising is an area of haemorrhage wihin the subcutaneaous tissue. It usually arises as a result of either blunt trauma or due to forceful pressure against a firm surface. It is the most common abusive injury that children sustain [15–17] and as such may be an important indicator that abuse has taken place, and that further enquiries/investigations are merited. Missing abusive bruising may be a lost opportunity to protect a child; it has been noted that 19% of children who were fatally abused had been seen by a doctor within the month prior to their death, and facial bruising was among the injuries seen [18]. As with all other injuries, it is important to differentiate between deliberate and accidental bruisies, and mimickers of bruising (Table 5.2).

Bruising is the most common finding in abused babies, and the face is a frequent site of abusive bruises [19, 20]. Bruises to a nonmobile child should

Table 5.2 Features of deliberate and accidental bruises and important mimickers of bruising

Bruises suggestive of physical abuse	Sites of common accidental bruising	Bruising mimics
• In children not independently mobile including babies • On the face (excluding the forehead), back, abdomen, buttocks, ears and hands • Not over bony prominences • Multiple and in clusters • Of uniform shape • With a clear pattern/imprint	• Knees • Shins • Forehead • Arms	• Disorders of coagulation – Haemophilias – Von Willebrand's – Idiopathic thrombocytopenic purpura – Henoch Schoenlein purpura • Dermatological conditions – Mongolian spots • Connective tissue disorders • Drugs (e.g. NSAIDS) • Cultural practices – Coining – Cupping

Fig. 5.1 Extensive bruising in a 7 yr old boy. (**a**) On presentation, all bruised were covered with paint with the parental explanation being that the children had been painting each other. Further investigation also revealed 7 fractures of differing ages. (**b**) The bruises show a yellow discolouration which is indicative of being 18–24 hours old or older

always alert a physician to the possibility of abuse. With the exception of birth related bruises, accidental bruising is extremely rare in pre-mobile infants (<1%), [21, 22].

Mobile children frequently sustain bruises during their normal day to day activities and the challenge is to accurately distinguish between these two (Table 5.2). It is estimated that 17% of children have bruises at any one time once they are crawling or cruising, increasing to 50% in those walking [21, 23]. When accidental bruises are present, they tend to occur over bony prominences [17, 21, 24]. Accidental facial bruises in toddlers are found in a "T" distribution over the forehead, nose, upper lip, and chin [25]. By contrast, abusive bruises to the face are predominantly over soft tissue such as the cheeks, mouth, and periorbital areas [26]. The neck and ears are very rarely bruised accidentally at any age [27]. Multiple bruises/extensive bruising in areas not usually prone to accidental bruising may also be an indicator of abuse (Fig. 5.1a).

Illustrative Case *This 7 year-old boy (Fig. 5.1a) was well known to child protection services in relation to parenting and care concerns. There had been reports of domestic violence, child sexual assault, failure to attend school, and the reported presence of repeated and multiple physical injuries. The injuries included, at different times, injuries to his mouth, the presence of bruises and a laceration at the base* *of his penis. The injuries had on each occasion allegedly been the result of self-harm. He represented for a forensic examination following a further report to protective services and was accompanied by his mother and stepfather. During the interview, it was noted that his mother was holding his hand firmly throughout and that the boy would not remove his cap. When examined, he was noted to have multiple areas of his body painted. The explanation for this was that he had been painting with his sister and they had painted each other. The paint was washed from his body revealing the presence of multiple bruises. Despite his age, a limited skeletal survey (excluding skull) was undertaken and this showed five rib fractures at different stages of healing and a healing fractured left femur.*

Once a child reaches school age, almost 80% will have some accidental bruising [22] with bruising to the shins, forehead and arms being the more common sites [21, 28]. Bruising to the hand is rare at all ages [19, 28] while bruising to the ears (Fig. 5.2), thighs, abdomen, and buttocks (Fig. 5.3) is significantly more common

Fig. 5.2 A case of physical abuse of a child showing bruising to and behind the ear a laceration in the groove between the ear and the scalp

Fig. 5.3 Excessive buttock bruising in a young child indicative of abuse

among abused than non-abused children [19]. If petechiae are found with the bruising, in the absence of an underlying coagulopathy, the bruise is significantly more likely to be abusive in origin, with a positive predictive value of 80% (95% CI 64.1, 90.0); however, the absence of petechiae has no significance either way [29]. On some occasions, either the positive or negative imprint of the weapon causing the bruise may be visible, emphasizing the need for high quality imaging of the bruise, as this may enable matching of the outline to a proposed object used to assault the child (e.g. belt buckle, dog collar, etc.) [24, 30, 31]. Imprint bruising showing a hand print, ligature mark, 'tramline' bruising (use of a cane, stick, etc.), grip mark or implement imprint are indictors of abuse [6].

It is important to remember that bruising may be a consequence of bleeding disorders, and as such, any investigation of a child with bruises of possible significance should include an appropriate screening for coagulation disorders, including a full blood examination, clotting screen, Von Willebrand Factor, Factor VIII, IX, XI, XIII and platelet function (Table 5.3); if any history suggestive of a bleeding disorder (bleeding after dental extraction, prolonged bleeding from umbilical cord, etc.) is present, then the case should be discussed with a paediatric hematologist as to the need for an extended screen of clotting abnormalities. A skeletal survey should be considered in children aged less than 2–3 years and selective radiology in older children with severe soft tissue injuries. As with all children, a detailed past medical history (e.g., in the case of an infant, was Vitamin K administered following birth, etc.), previous episodes of prolonged bleeding or bruising, drug history (e.g., regular use of NSAID), and a family history of bleeding disorders should be sought. Idiopathic thrombocytopenic purpura is a relatively common temporary disorder of clotting that may resemble bruising. Similarly, although not a disorder of coagulation, Henoch Schoenlein purpura may present as a sudden onset of bruising affecting, usually, the lower limbs and buttocks. Connective tissue disorders are another consideration (e.g. Ehlers Danlos Syndrome) (Table 5.2).

Other potential mimickers of bruises include dermatological disorders and cultural practices. Mongolian spots and other variants of slate-grey naevi (Nevus of Ota and Naevus of Ito) are not infrequently misdiagnosed as bruises and are common on

Table 5.3 Suggested baseline laboratory and radiological investigations for specific types of trauma

Bruises	Fractures	Burns	Abdominal trauma	Abusive head trauma
• Full blood examination • Clotting profile • Platelet function If required, a more extensive clotting factor profile: • Von Willebrand factor • Factor VIII, IX, XI, XIII In children aged <2 years of age: • Skeletal survey	• Alkaline phosphatase • Calcium • Phosphate • Parathyroid hormone • Vitamin D • Urea and creatinine In children aged < 2 years of age: • Radionuclide bone scan • Skeletal survey	In children aged <2 years of age: • Radionuclide bone scan • Skeletal survey	• Full blood examination • Liver function tests • Amylase and lipase • Urine ward test • Ultrasound and/or CT	• As for bruising if bruising and/or intracerebral haemorrhages present • Urine metabolic screen • MRI and/or CT brain • MRI neck • Radionuclide bone scan • Skeletal survey

The choice of investigations will, however, be dependent upon the circumstances of the presenting complaint and age of the child

the back and buttocks. Other congenital disorders including epidermal naevi, hyper-pigmented macules and vascular cutaneous markings (e.g. haemangioma) need to be distinguished from bruises. Vascular lesions blanch and this may help distinguish them from bruises. Alternatively, a follow-up examination demonstrating a failure of the 'bruise' to resolve will provide the distinction.

There are some cultural practices that may result in bruising or bruise-like markings and these include coining and cupping. These practices are all health-related and believed to treat various illnesses. Coining involves taking a smooth-edged object like a coin and rubbing it along the skin in a linear fashion until a bruise is present. Cupping results in circular bruises due to suction from small cups or glasses placed on the skin.

Clinicians are often asked to date the bruises present, and it has long been the practice to do so on the basis of the color of the bruise [30]. There is no published scientific evidence to support such an estimation other than the presence of a yellow discolouration indicating a bruise 18–24 h old or older [31, 32] (Fig. 5.1b).

Oral Injury

As the head is one of the most common areas of the body to be injured in abuse, it is surprising that intraoral injuries are not recorded more frequently, being found in only 6–11% of abused children [33, 34]. All the studies to date have been retrospective, begging the question as to how often the mouth has actually been fully examined. It is a vital part of the assessment of suspected abuse, as almost all forms of intraoral injury have been described abusively—torn labial/lingual frenum, dental intrusions, extrusions, fractures, laceration, and even bites to the tongue [35]. A torn labial frenum has been deemed to be "pathognomonic" of child abuse in young children, as its earliest descriptions by Cameron and later Tate recorded this injury in severely abused children [36, 37]. It is recognized that this injury can occur in mobile toddlers and older children who accidentally sustain a direct blow to the upper lip [38]. It may also occur during resuscitation [39]. Unfortunately, there are no large scale comparative studies defining the pattern of such injuries found accidentally and abusively. What is clear, however, is that when a torn labial frenum occurs in child abuse, it is usually accompanied by severe, if not fatal, coexisting injuries [36, 38, 40]. As such, it is imperative that any infant or young child found to have a torn frenum should be fully investigated, as failure to do so may lead to the child being sent home, and subject to further abuse [41]. If a full physical assessment, including a skeletal survey in those <2 years of age, and a full social assessment, does not reveal any other abnormal findings or concerns, a torn frenum in isolation cannot be assumed to be abusive.

Other oral findings may be relatively subtle to physicians including microfractures which lead to gray discoloration of the teeth [42]. Likewise, the discoloration found in dentinogenesis imperfecta is an important finding as this may coexist with osteogenesis imperfecta, an important differential diagnosis of fractures in a young child [43]. It is important for examining physicians to know the expected primary/secondary dentition, as there have been reports of forced extraction of the teeth by parents as a form of "punishment" [44]. This highlights the need for physicians to work closely with their dental colleagues (and vice versa) in the event that any unexplained or unusual intraoral findings are identified.

Bites

Bites are a common injury in childhood [45], predominantly caused by other children or animals. They appear as bruises and lacerations to the skin. Often they present as an oval injury with opposing convex arcs and occasional central bruising (Fig. 5.4). Injury in the arcs is not usually continuous (unless the injury has aged and the bruising diffused) with foci of bruising or laceration as a mirror image of the perpetrator's teeth. Animal bites, such as dog bites, are easily distinguished from human bites in that they tend to be more 'V' shaped compared with the human 'U' shape. Animals have a longer narrow jaw, and tend to tear at flesh rather than crush it [46–48]. Children sustain abusive bites in any location, but the commonest appear to be arms, legs, back, shoulders, and buttocks [49]. A human bite is described as 2–5 cm oval or circular injury. Classically, measurement of the intercanine distance [50] is used to distinguish child and adult bites. Indicative intercanine distances are as follows:

Fig. 5.4 Human bite mark on the arm

- 2.5–4.5 cm (>3.0 cm) - consistent with an adult human bite;
- <2.5 cm - a child (deciduous teeth); and
- 2.5–3.0 cm - a child or small adult.

It must be borne in mind that there may be racial and individual differences in intercanine distances, and that “adult” dentition is reached by 12 years of age. Nonetheless, it is vital to identify an adult bite on a child, as it is the only physical injury which may afford the opportunity to identify a specific perpetrator, either by retrieval of DNA from the bite itself, or by reconstruction of the dentition of the perpetrator by a forensic dentist [51]. This is just as important to rule in as to rule out a specific suspect.

Sometimes, bites can be confused with dermatological disorders, such as ring worm but a key difference is the presence of scaling in dermatological disorders.

Given the potential significance of an abusive bite, it is vital that appropriate photographs are taken at the time, using a right angled measuring device, and if the bite is on a curved surface (e.g., upper arm) to take photos in each plane. Ideally, photographs should be taken with the child in the position they were bitten [47]. A forensic dentist should be contacted as soon as possible. In the event that a child cannot be seen immediately by a forensic dentist, serial photographs on a daily basis may be helpful, as the precise dental imprints may become clearer over time as the surrounding induration reduces.

Abrasions and Lacerations

Both abrasions and lacerations are the result of blunt trauma [48]. Abrasions (a scratch or a graze) are an injury to the body causing disruption to the epidermis of the skin. The injury is caused by a combination of pressure and movement across the surface of the skin. It is an important injury in that it represents the site of contact with the implement or surface that may have caused the injury and may identify the direction of the force. Lacerations, as distinct from incisions, occur from blunt trauma. A laceration is a tearing/splitting of the skin producing an injury that extends beyond the epidermis and into the underlying tissue layers. The cause in children may be from accident (e.g. falls) or as a result of abuse. Accidental lacerations and abrasions tend to occur in a similar distribution to accidental bruises and may appear over bony prominences such as the knees shins and forehead. Suspicions of abuse arise in the following circumstances [24]:

- when the explanation for the injury is incompatible with the injury;
- on a child who is not mobile;
- where the injuries are multiple;
- where the injury is symmetrical in distribution;
- on areas usually protected by clothing;
- involving the eyes, ears and sides of the face; and
- on the neck, ankles and wrists where there may also be appearances of ligature marks.

Thermal Injury

There are many different types of burns (ie. thermal, chemical, electrical, radiation, and friction) but the most relevant to child abuse are thermal injuries. These injuries include both hot and cold burns and may result from immersion, splashes and direct contact.

It is estimated that up to 25% of children admitted to burns units, may be suffering from an abusive burn [52]. Abusive burns not only carry a higher mortality, but they lead to significant short and long term morbidity with the need for frequent dressing changes, surgery, and possible scarring and contractures in addition to the psychological consequences [53].

The most common intentional burns described in the literature are scalds, with hot water immersion burns being the more frequent pattern [54–56] (Fig. 5.5). While the typical pattern for abusive scalds involves the feet and legs, with or without buttocks/perineum, it may also involve both hands and feet, or one hand, or may involve only the face [54, 57]. Classically, these burns have a consistent burn depth,

Fig. 5.5 Immersion burn that resulted in a fatality. A clear distinction is illustrated between burnt and spared skin

and have a clear upper margin [58], sometimes giving rise to the “glove and stocking” appearance [56, 59]. This pattern contrasts with the typical accidental scald, which occurs as a “spill over scald” where the child reaches up and pulls a hot drink over itself, scalding its face, upper limb, and upper trunk [60]. Here, the burn is deepest at the point of contact with the hot liquid and decreases in depth as the liquid reduces in heat and amount as it flows away from this point. With the increasing use of microwaves and “ready meals,” there has been an increase in accidental spill burns due to hot food items in older children or to a small child who is in the care of a teenager. Burns are one injury where the injury found is directly related to the causative agent and duration of exposure. As it only takes 1 s for a child to sustain a full thickness burn from a liquid at 60 °C [61], if the history is that the child accidentally immersed itself in the bath water for only a matter of seconds, it is vitally important to find out what temperature the domestic water temperature in the house is set at, a fact which surprisingly few people know about their own home [62]. Likewise, if it is suggested that the child climbed into the basin and turned the tap on itself, causing a running water burn, a home visit is necessary combined with an appropriate developmental assessment [63]. Could this child have climbed into that basin? What way was he facing when the parent came into the bathroom? In other words, if the burn is on the left leg, would this have been the leg closer to the hot tap in that particular basin? When assessing a potentially abusive scald, it is important not only to assess the burn itself (agent, pattern, mechanism, distribution) but also to look for other risk factors, for example, are there other unrelated injuries at the time of the burn, was a sibling blamed, have there been previous burn injuries, is it developmentally appropriate, is there interpersonal violence in the home, have there been frequent emergency attendances, is the child behaving abnormally in light of such a painful and distressing injury [57, 63, 64]? Any child with a suspicious burn, aged less than 2 years, should undergo a skeletal survey, as it is recognized that up to 14% of children with abusive burns may have occult fractures [65].

Children may sustain other abusive or neglectful burns, such as radiation burns (sunburn) (Fig. 5.6), contact burns (e.g. from domestic irons) [66], caustic burns [67], and microwave burns [68]. While there are no uniform criteria for diagnosing abuse


Fig. 5.6 Sunburn to the shoulder

in these situations, the key message is to be vigilant, and take a very careful history to ensure that the injury found is compatible with the child's development, the agent, and way it is supposed to have occurred (e.g. if a child has an iron burn, clearly demarcated, full thickness on the back, this is unlikely to be consistent with pulling an iron down on itself). It is also important to know what clothing the child may have been wearing at the time as this may provide protection and explain unusual injury presentations (e.g. point burns corresponding to metal fastners in a woollen jump-suit). With the increasing use of hair curlers/straighteners among teenagers, there has been a rise in accidental burns among toddlers from such devices [69]. These may cause burns to both the dorsal and plantar aspects of the foot as the toddler stands on straighteners left on the floor and the straighteners flip over and makes contact with both aspects of the foot, or the toddler snaps it onto its foot. Parents often do not realize that these devices may reach temperatures of around 145° within 2 min, and stay hot enough to cause full thickness burns for up to 7 min after they are turned off.

There appears to be no study comparing the features of accidental vs. intentional cigarette burns. The few intentional ones recorded in the literature were circular / punched out lesions approximately 1 cm in diameter [70]. These injuries, however, are regular presentations in forensic assessments. Cold injuries (e.g., hypothermia; swollen red hands and feet) are not a common presentation in temperate climates. There is also no published literature identified that has documented associations between cold injury and child abuse. Presentation of such injuries, should they occur, without a suitable history may be a sign of child abuse [24].

First line forensic investigations for potential abusive burns assessments are limited and will depend upon the case presentation. For children, however, aged less than 2 years of age, with suspicions of abuse, then a skeletal survey and bone scan should be considered (Table 5.3).

One area of difficulty in assessing burns is the child who has been "treated" with moxibustion, a form of traditional remedy. This involves burning the Moxa herb directly over the site of the symptoms (e.g. around the umbilicus in abdominal pain), thus producing a series of circular well demarcated burns; likewise “cupping” (discussed above) can cause multiple circular superficial burns. Another therapeutic burn is Maquas which involves cauterization of the skin with a red-hot iron. While these may have been “inflicted” on the child, they are intended to be “therapeutic” for the underlying condition, and it is important that clinicians are aware of such practices, particularly among South Asian families. There are a number of medical conditions that may mimic burns. Included are bullous impetigo, ammoniacial rashes, eczema and staphylococcal skin infection (scalded skin syndrome). It also needs to be borne in mind that children with Attention Deficit and Hyperactivity Disorder (ADHD) do sustain more accidental burns than the rest of the childhood population [71], and this may not reflect neglect as such but highlight the challenge parents have in preventing such accidents in this group of children.

Self-Inflicted Injury

Self-inflicted or self-harm injuries occur within all age groups but are more likely seen in adolescents than younger children [48, 72]. The difficulty with these injuries is ascertaining whether they are the result of an accident, deliberate harm by another person or the result of self-infliction. The nature of self-harming injuries encountered are many and include bruises, abrasions, lacerations, incisions, stab wounds, bites and burns. Some of these injuries may result in death and some were intended to cause death but the attempt was unsuccessful. Others may be cries for help or an indicator of frustration. Some are used as a means of avoiding parental or school discipline (e.g. failure to complete homework; explanation for late return home). There are specific features regarding these injuries that assist in identifying their potential of having been self-inflicted [48, 72]. These include:

- all injuries tend to be of a similar injury type (e.g. all bruises or all abrasions) although they generally consist of abrasions or incisions rather than bruises or lacerations;
- all injuries tend to be of a similar severity (e.g. all abrasions are of a similar severity) and in most cases tend to be superficial (Fig. 5.7);
- the injuries are in accessible sites for the individual;
- the injuries tend to occur on the non-dominant side of the body (i.e. a right-handed individual will create injuries affecting the left-hand side of the body);
- the injuries are often multiple and parallel;
- the injuries generally do not involve vital structures such as the eyes but tend to involve non-vital structures such as the face, chest, abdomen, arms and legs;
- overlying clothing may be spared; and
- there is an absence of defensive injuries.

Illustrative Case *This 13 year old girl (Fig. 5.7) alleged that she had been assaulted by her father with a razor. There was a history of behavioral problems. The razor*

Fig. 5.7 Self-inflicted abrasions in an adolescent alleging assault by her father with a razor

was stated to be a double-bladed disposable razor and the allegation was that the blade had caused the injuries to her back. The girl was right-handed. Examination showed the appearance of linear abrasions diagonally across the mid—lower back many of which were of similar severity. There were no lacerations. Based upon the allegation and the nature of injuries sustained, the appearances were suggestive of self-infliction. When confronted with this hypothesis during the consultation, the patient eventually confirmed that she had actually caused the injuries, the intention being to 'get back' at her father for his implementation of discipline within the home and limiting her visitation with friends.

Abdominal Injuries

Although abdominal injuries are rarely recorded in abused children, prevalence estimated at 1–8% of abuse cases, they are recorded as the second commonest cause of fatal abuse after head injuries [12]. Among abdominal injuries, liver and bowel injuries occur with almost equal frequency, although it is worth noting that accidental duodenal injury, which is the commonest abusive bowel injury recorded in the literature, is an extremely rare accidental injury in children less than 4 years of age, and no small bowel injuries have been recorded in children <5 years old as a consequence of a fall [12]. Almost every organ in the abdomen has been injured abusively, but the true prevalence of these injuries is difficult to determine because of the lack of high quality epidemiological data. It is estimated in the United Kingdom that 0.9 cases/million children/year (95% C.I; 0.58–1.39) present with an abusive abdominal injury [73].

The clinical presentation of those with abusive abdominal injury varies; bruising to the abdomen may be present in up to 60% of cases [73], but other studies note that up to 90% of children had no abdominal bruising [74]. Lindberg et al. [75] have attempted to assign a probability of abusive abdominal injury in the presence of abdominal bruising, where they estimated a positive likelihood ratio of 7.9, and a negative likelihood ratio of 0.7; thus, its presence is highly suspicious, but its absence does not mean serious injury is not present. Abdominal symptoms, for example, distension, vomiting, reduced bowel sounds, and tenderness were all positively associated with significant injury, although significant injury can be present in the absence of these signs [75]. Although abusive abdominal injuries tend to occur in younger children than accidental abdominal injuries (2.5–3.7 vs. 7.7–10.39 years), and hollow organ injuries are commoner among this group, alone or in combination with solid organ injuries, there are few other distinguishing features [76]. Delayed presentation was not a discriminator as children with low velocity accidental injuries also presented late. A high index of suspicion should be used if a child <4 years presents with abdominal symptoms suggestive of internal injury without an explicit history of blunt injury. Overall, the signs and symptoms of visceral injury vary from non-symptomatic to the lift-threatening. The investigative approach is as for blunt trauma from accidental injuries [77] and may include amylase, lipase, liver function, a full blood examination and either ultrasound and/or CT (Table 5.3).

Fractures

Fractures are the second most common injuries in abused children, second only to bruising [78]. They represent an application of physical force that is either directly or indirectly applied. Direct forces may result in a transverse or communited fracture at the point of impact whereas an indirect force may result in a fracture distant to the site of force application. Twisting results in spiral fractures and a combination of bending and compression may result in an oblique fracture. Associated with all fractures will be some degree of soft tissue injury and haemorrhage, and there may also be associated cutaneous bruising. Avulsion fractures may occur and joint injuries should not be overlooked [48].

Most skeletal injuries in children are accidental and are common about the wrist and forearm for those aged between 5 and 18 [79]. Fractures due to abuse are more common in children under the age of 2 years. In 1986, Worlock et al. [80] showed that 80% of abusive fractures occurred in children under 18 months while 85% of accidental fractures are seen in children aged 5 years and over. Abusive fractures are frequently clinically occult; they may be multiple and of different ages [80, 81]. Any fracture can occur as a result of physical abuse, but some have a higher specificity than others. Given the extent and variation of fractures with age the reader is referred to *Diagnostic Imaging of Child Abuse* by Kleinman [82] and the RCPCH Child Protection Evidence website [83].

Kleinman et al. [84] and Flaherty et al. [85] describe certain fractures that have specificity for child abuse. Those with a high specificity include the classic metaphyseal fractures of long bones, postero-medial rib fractures in infants, scapular fractures and spinous process and sternal fractures. Those with moderate specificity include multiple fractures in the same child, fractures of differing age, epiphyseal separations, vertebral body fractures and subluxations, digital fractures and complex skull fractures. Those of low specificity include subperosteal new bone formation, fractures of the clavicle and long-bone shafts, and linear skull fractures.

Rib fractures have the greatest specificity for physical abuse [86, 87]. The fractures are most likely to be multiple, affecting ribs on one or both sides of the thorax. They can be located at any point along the ribs; anterior rib fractures appear to be more common in abuse than nonabuse, and lateral fractures are more commonly seen in accidental injury, while posterior rib fractures are reported in both situations but are a predictor of high specificity for abuse in infants [84, 85].

Humeral and femoral fractures have a higher risk of being abusive than accidental in children under 18 months of age. Pandya et al. [87] showed that in children over 18 months of age both humeral and femoral fractures are more likely to be accidental. As far as fracture types are concerned, supracondylar humeral fractures are strongly indicative of an accidental injury [88]. There is no difference between the type of femoral fracture in abusive and nonabusive injuries which are most commonly mid shaft, with the exception of spiral fractures that were recorded as the most common abusive femoral fracture in children under 15 months of age [89].

No skull fracture pattern is disgnostic of abuse. Linear fractures (especially single, linear parietal skull fractures) are low-specificity fractures and falls from modest heights (up to about 1.5 m) explain most of this type of fracture in infants [90]. It is estimated, however, that as many as one in three skull fractures in preschool children are abusive [86, 87].

Metaphyseal fractures have been described as characteristic of physical abuse [80, 82, 85, 91, 92] and appear to occur more frequently in abuse than following accidental injury. They have also been described as birth related injuries [93] and following serial casting treatment of talipes deformity [94]. The presence of unexplained metaphyseal lesions in an infant always warrants further child protection investigations.

Skeletal spinal injuries are reported in physical abuse. Cervical injuries have been reported in association with abusive head trauma in babies and thoraco-lumbar fracture dislocations in toddlers [95]. These injuries may be associated with injury to the spinal cord. If spinal skeletal injuries are suspected, a spinal magnetic resonance imaging (MRI) scan should be conducted to exclude spinal cord involvement.

Skeletal fractures have been described in up to one-third of children who have been physically abused [96]. In light of the fact that children under 2 years of age are at greatest risk and that fractures may be clinically occult, it is important that skeletal injuries are excluded in any child under 2 years of age when physical abuse is suspected. The American Association of Pediatrics, the Royal College of Radiology and the Royal College of Paediatrics and Child Health set out guidelines for the radiological investigation of children suspected of child abuse [97, 98]. They recommend an initial comprehensive skeletal survey that includes up to about 20 X-ray images to visualize the entire skeletal system adequately. Other countries have their own specific but similar regimes. Studies confirm that oblique views of the thorax increase the chances of identifying acute rib fractures [99] and that lateral views of the vertebrae are essential to exclude spinal skeletal injury [95]. Repeat skeletal surveys at 10–14 days have been shown to confirm the identity of ambiguous findings and to identify additional features not seen on the initial survey, particularly rib and metaphyseal fractures, and to support an opinion regarding the age of a fracture [100, 101]. In some regions, a radionuclide bone scan is conducted at the same time as a skeletal survey to improve identification of occult fractures in children under 2 years of age. In the absence of this facility, or should the parents of the child object, a repeat survey in 10–14 days is recommended. For children older than 2 years, radiology should be directed to the site of clinical suspicion.

Precise dating of fractures cannot be achieved [102]. Experienced pediatric radiologists are often prepared to offer an opinion on the age of fractures in broad terms according to the radiological appearance of the extent of fracture healing. Textbooks offer time intervals for the different stages of fracture healing based on the experience of radiologists [80].

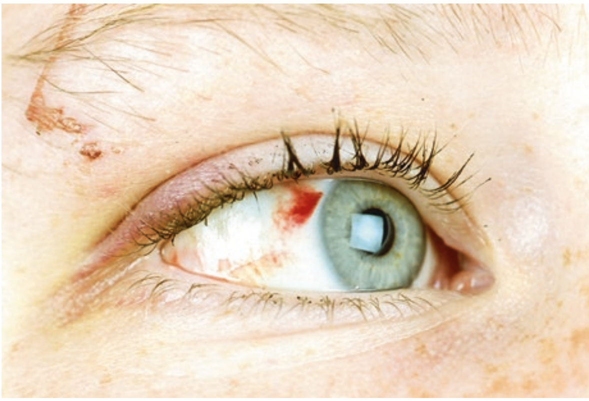
Any comprehensive clinical and forensic assessment must exclude conditions such as accidental injury, birth trauma, infection, rickets, osteogenesis imperfecta, and metabolic bone disease of prematurity in their differential diagnosis. A comprehensive birth history, as well as family and nutritional history, is as important as detailed scrutiny of skeletal images for markers of these conditions [103]. Laboratory investigations may include serum alkaline phosphatase, calcium, phosphate, parathyroid hormone, vitamin D, and urea and creatinine (Table 5.3).

Other Physical Injuries

There are a number of other potential injuries that may be identified in child physical abuse that have not been addressed above. These include hair loss, eye trauma, ear trauma (ruptured tympanic membrane), trauma to the finger and toe nails, and spinal injuries. Injuries may also occur to the genitalia and anal region unrelated to a specific sexual assault. They are, however, considered under descriptions of injuries associated with sexual assault and will not be further discussed here (see Chap. 3).

Hair loss (principally head) may be the result of either trauma or it may fall out spontaneously because of an underlying medical condition (e.g. scalp infections) or as a result of chemotherapy. Published documentation regarding the association

Fig. 5.8 Subconjunctival/scleral haemorrhage



between hair loss and child physical abuse has not been identified but should be considered in unexplained cases of hair loss.

Eye injury resulting from physical abuse is not uncommon. Subconjunctival haemorrhages are common and may result from direct trauma, attempted suffocation, neck compression (strangulation), and chest or abdominal compression (Fig. 5.8). They may also arise from birth trauma, forceful coughing and vomiting, and a too forceful Valsalva. Direct trauma may also result in corneal or scleral laceration, vitreous haemorrhage, acute hyphema and retinal detachment. Retinal haemorrhages have many causes but are an important consideration in abusive head trauma (see below). When assessing eye injuries, non-accidental causes should be considered when differentiating accidental and medical causes.

Spinal injuries are rare in childhood and potentially have significant morbidity and mortality [24]. They have a greater association with accidental trauma and are uncommonly reported in child abuse. They may, however, be associated with abusive head trauma which is described below.

Abusive Head Trauma

Abusive head trauma (AHT) is a difficult and challenging area of paediatric forensic medicine and is a condition that should be managed by experienced forensically trained physicians. AHT is a large topic but will only be briefly described here. It has been beset by theories and debate and its title, abusive head trauma, is a more recent term that replaced names such as ‘shaken baby syndrome’, ‘inflicted traumatic brain injury’ and ‘non-accidental head injury’. The clinical outcome for children with AHT is poor and considerably worse than for those children with non-AHT [104–106]. It is the principal cause of fatal head injuries in children under 2 years of age [17, 107, 108]. Studies quote mortality rates of 8% [105] to 30% [11] in infants with AHT, and up to a half the victims of AHT sustain persistent neurological impairment. The estimated incidence of infants under the age of 1 year who are admitted to hospital is 20–24/100,000 year [11, 109]. This rises to 36/100,000 for infants under

6 months old [11]. In practice, this means that physicians and pediatricians in non-specialized pediatric inpatient settings can expect to see a case infrequently, while pediatric intensive care and pediatric neurology units will do so on a regular basis.

It is widely accepted that AHT arises from shaking, impact injuries, or a combination of both. One study reports that 2.6% of American parents admit to disciplining their infant children by shaking them, figures from less-developed countries are considerably higher [110]. It is, therefore, likely that hospitalized cases are only a proportion of a much wider issue.

AHT consists of multiple components including one or a combination of skull fractures, subdural and other intracranial hematoma, intracranial and spinal changes including hypoxia and cerebral contusions, complex retinal hemorrhages, and rib and other fractures that are inconsistent with the provided mechanism of trauma. Clinically, presentation is varied and includes infants who present with unexplained traumatic brain injury or infants with other signs of physical abuse where intracranial injury is identified in the course of a full clinical investigation. Symptomatology can vary from a child who is dead at admission to children who present to hospital with a variety of neurological symptoms of varying degrees of impaired levels of consciousness, seizures, or apneic episodes, and some children presenting with minor degrees of irritability or impaired feeding without overt neurological symptoms [11, 105]. The findings may be incidental where the child presents for an unrelated condition.

One study [105] compared the presenting history of a group of children under the age of 3 with definite AHT with that of children with non-inflicted head trauma. They concluded that there is a high likelihood of abuse in children who have traumatic intracranial injury with no history of trauma or in children with persistent neurological impairment and a history of low impact fall (equivalent to falls of less than 1 m). They also showed that an explanation of out of hospital cardio-pulmonary resuscitation or a changing history or one where alternative traumatic explanations were offered was more common in cases of definite abuse. Low impact trauma was not specific for abuse in children without neurological impairment, consistent with the fact that low falls can cause skull fracture and rarely intracranial injury which is unlikely to be severe enough to cause neurological impairment. Late presentation to hospital and sibling involvement did not appear to be significant discriminatory features.

Ever since 1946 when Caffey [111] entitled his article "Multiple fractures of long bones of children suffering from subdural haematoma," it has been accepted that a number of features are often associated with AHT. Along with bruises and other cutaneous injuries these children may sustain different combinations of fractures, retinal hemorrhages, apnoeic episodes, and seizures more commonly than children with traumatic injury of a known accidental cause.

Retinal Haemorrhages

Retinal hemorrhages (RHs) are strongly associated with AHT. Studies have identified RHs in 70–80% of cases of confirmed AHT [112]. In contrast, they are seen in fewer than 10% of nonabusive head injuries. In the majority of cases of AHT, the hemorrhages are widespread throughout the retina, extending to the periphery [113]. They are more often bilateral than unilateral, and are commonly found throughout all layers of the retina. When they are present after accidental head injury, the hemorrhages are predominantly few in number and located primarily at the posterior pole or around the optic disc. They are often unilateral. More wide spread hemorrhages are seen after crush injuries to the head and high falls. Numerous additional retinal features have also been reported in either condition; retinal schisis and perimacular folds have been reported in AHT and nonAHT following significant crush injuries or high fall (>35 ft.). While there are features of RH that are undoubtedly strongly indicative of AHT, there is no pattern that is pathognomonic to either condition. It is important therefore that any child with suspected AHT has a retinal examination performed by an ophthalmologist using indirect ophthalmology. Findings should be accurately recorded including the number, distribution, laterality, and layers of retina involved together with documentation of any additional ophthalmological findings. A photographic image may provide a valuable record of the findings.

It should also be remembered that there are numerous other conditions associated with RHs in the age group at risk of AHT. These include some conditions that may have other features common to physical abuse such as coagulopathy disorders, birth-related retinal hemorrhages, metabolic disorders such as glutaric aciduria, homocystinuria, and osteogenesis imperfecta [114]. Other conditions such as cardio pulmonary resuscitation, apparent life threatening events (ALTE), epilepsy, and cough have been proposed to predispose to RH. However, there are very few published studies to help answer this question. RHs rarely occur after seizures and have not been reported in the literature in association with cardio pulmonary resuscitation, ALTE, or persistent coughing; however, published case series are small and inadequately powered to address the question with certainty.

Apnea and Seizures

Apnoeic episodes are increasingly recognized in association with AHT, which appears to coincide with the fact that hypoxic ischaemic injury is commonly seen on MRI images of these children [115] Multiple factors are proposed to account for the apnea, such as respiratory insufficiency in an infant who is subjected to repeated traumatic events or damage to the respiratory control centers in the brainstem. Seizures are more strongly associated with children with AHT; prolonged seizure activity may exacerbate further hypoxic ischaemic damage to the brain through excitotoxic mechanisms or by inducing further respiratory insufficiency [115].

Fractures

Rib fractures and long bone fractures have been found to be associated with AHT. By comparison, skull fractures are associated with both abusive and non-AHT.

The explanation proposed is likely to be the fact that most cases of non-AHT arise from falls or impact injuries that predispose to skull fractures whereas AHT may include shaking injuries with or without impact.

Intracranial Haemorrhage and Brain Contusions

Subdural hemorrhage (SDH) is associated with AHT and must be considered as a possible diagnosis in any child with an unexplained SDH. Subarachnoid hemorrhages are recorded equally in both abusive and non-AHT while extradural hemorrhage is significantly associated with non-AHT [116–120]. In a comparison of non—accidental and accidental causes of SDH, there are certain features of SDH that are far more commonly associated with abuse and these include: –

- being bilateral;
- multiple bleeds;
- located in the inter-hemispheric fissure or falx;
- of differing densities;
- in the absence of skull fractures; and
- in the presence of a retinal haemorrhages.

Intracerebral changes of AHT include cerebral oedema [118] and hypoxic ischemic injury [115]. Subarachnoid haemorrhage is also relatively common in association with abusive brain injury and often occurs in association with subdural haemorrhage. Other changes that may be identified include brain contusions and diffuse axonal injury. Contusions may occur in young children due to acceleration-deceleration mechanisms and impact but they are less common than in older patients. They may occur adjacent to skull fractures. Contrecoup contusions may also be identified. Diffuse axonal injury due to rotational angular acceleration-deceleration forces may result from both shaking or blunt impact and may be identified on MRI.

Investigation of AHT

Radiology plays an important role in the investigation of AHT and current guidelines [97] suggest that CT is the first investigation of choice because of the widespread availability and technical ease of performing CT on a sick child on admission to hospital. MRI has added benefits and should be performed as soon as possible [121, 122]. In some centers with the appropriate expertise, MRI is increasingly accepted as the first line investigation. MRI is better at identifying small SDHs in areas obscure to CT imaging and is more sensitive to lesions within the brain parenchyma itself, which may provide prognostic information. MRI can help to differentiate subarachnoid hemorrhage or low attenuation subarachnoid fluid collections that may be consistent with a benign hygroma of infancy. Dating the intracranial trauma may be achieved utilizing signal analysis of resolving SDH on T1 and T2 weighted and FLAIR sequences [123]. It is important to consider extending the MRI to include the cranio cervical junction and spinal cord to exclude coexisting spinal injury which has been shown to be present in a number of cases. The reader is referred to a succinct overview of the appropriate radiological investigation of suspected AHT in children, interpretation of findings and the consideration of pitfalls in a recent review by Rao and Smith [124].

All cases of AHT should be assessed by an ophthalmologist at the earliest opportunity.

In all cases of AHT, a skeletal survey, nuclear bone scan and bone biochemistry should be arranged. In cases where haemorrhages are identified, the investigation should be as for bruising (Table 5.3). In some cases, a urine metabolic screen may be judicious in excluding potential mimics of AHT.

Mimickers of AHT

The differential diagnosis of AHT is extensive and has been detailed by Sirotnak [125]. The conditions may include accidental head injury, coagulopathy disorders, genetic conditions such as osteogenesis imperfecta, metabolic conditions such as glutaric aciduria and galactosaemia, birth related SDHs, cerebral infections, and benign extra axial fluid collections in infancy. These must all be considered within the diagnostic process.

Fabricated or Induced Illness

Fabricated or Induced Illness (FII) is a term used for child abuse where a child suffers harm (or is placed at risk of harm) as a result of fabrication (lying) or induction (causing) of illness by an adult carer. There is a spectrum of severity ranging from purely iatrogenic harm that arises when carers provide false information to doctors who then proceed to investigate or treat children unnecessarily, to severe physical abuse inflicted by carers who repeatedly present their children to medical services after smothering, poisoning, or other illness induction. These latter cases are often fatal whereas "fabrication only" cases are rarely fatal. All children exposed to this behavior are likely to suffer significant harm, both emotional harm arising from the unnecessary adoption of a "sick role" and physical harm which may be largely iatrogenic. Other forms of abuse may coexist and there are often very extensive difficulties with parent–child interaction that extend well beyond the medical interface.

FII replaced the previous term "Munchausen Syndrome by Proxy" (MSBP) in the United Kingdom in 2002 [126]. MSBP had widely been misinterpreted as a psychiatric condition in the carer "suffering from" MSBP. The term FII placed the focus back on to the child and the abuse it was suffering. Most observers suggest that there may be many pathways to fabrication that vary between perpetrators [127].

The focus tends to remain on the child and any supplementary diagnosis of the parent would depend on their discrete clinical features [128].

The core concept of FII is that the child does not have a medical condition that explains the symptoms described by the carer. The history is incongruous with the child's clinical features and investigation results and the overall presentation is perplexing for the physician.

The Wider "Spectrum" of FII Concerns

There are other situations where a child may be presented for medical attention with symptoms that sound serious, yet the child does not have a medical condition that explains their presentation. Table 5.4 provides a useful basis for a differential diagnosis of FII. It should be recognized that some exaggeration by carers is common and simply reflects the carer's anxiety about the child's condition and his/her need to gain the attention of the treating physician. All physicians should possess the skills to deal with this without recourse to child protection procedures. Persistent exaggeration and fabrication that has the potential to lead to harm to the child is a more serious situation that must be addressed. Of these examples, only type 3 would generally be recognized as FII by pediatricians. This categorization is not exhaustive; for example, it does not deal with situations where carers are "malingering by proxy" [129] or attempting to defraud the state by lying about illness, nor does it encompass those situations where children actively fabricate their own illness.

While most FII cases are presented to pediatricians, some may be presented to child psychiatrists with unfounded complaints such as autism spectrum conditions, eating disorders, chronic fatigue, non-organic symptoms, or ADHD [130–134]. The carers involved may have complex reasons for presenting and may genuinely believe that their child has the condition, that is, different from the classical pediatric fabricating parent. They may have vested interests in obtaining a diagnosis; for example, they may need to feel that they are not responsible for their child's problems (or the problems of parent–child interaction), and they may want disability benefits for the child.

Some carers become convinced that their child has suffered abuse and may present repeatedly to child protection agencies requesting forensic assessment [135–138]. Some cases present in an education setting with carers who attempt to procure special educational support for a child who simply does not have the disability that is reported by the carers. In any of these situations, if there is concern that the child is at risk of harm and the situation cannot easily be resolved, then a child protection/safeguarding referral may be indicated. These situations may not fit comfortably under the label of FII as in many cases there is not good evidence that the carer is deliberately fabricating the child's illness.

Most perpetrators are mothers although a small number of cases involving fathers have been described [139–142]. No consistent psychopathology has been identified in FII perpetrators although some have personality disorder [143–145]. Certain characteristics have been observed in some cases, such as the following:

Table 5.4 The range of situations where fabricated or induced illness (FII) concerns may arise [210]

Starting point: A child is presented for medical attention, possibly repeatedly, with symptoms or signs suggesting significant illness but an appropriate clinical assessment suggests that the child's "illness" is not adequately explained by any disease. The examples below illustrate the range of possible considerations				
Example 1	Example 2	Example 3	Example 4	Example 5
Type of presentation				
Simple anxiety, lack of knowledge about illness, over interpretation of normal or trivial features of childhood. May in some cases be associated with depressive illness in carer	Child's symptoms are being misperceived, perpetuated, or reinforced by the carer's behavior. The carer may genuinely believe that child is ill or have fixed beliefs about illness	Parent actively promoting sick role by exaggeration, non-treatment of real problems, fabrication (lying), falsification of signs, and/or induction of illness (i.e., "True" FII) [a]	Parents suffering psychiatric illness, e.g., delusional disorder	Unrecognized genuine medical problem becomes apparent after initial concern about FII [b]
Underlying factors				
Carer's need to consult a doctor may be affected by other social stresses, mental health issues, or coping abilities of carer	"Illness" may be serving a function for carer, and subsequently for an older child too (secondary gains)	There may be a background history of frequent use of health services or apparent dependency on health care. Carer may have personality disorder or the child's "illness" may be serving a purpose for the carer	Usually not difficult to recognize	Possibility of "false positive" child abuse diagnosis must always be considered. Child's clinical progress should always be monitored in case a genuine illness has been missed
Insight				
Carer usually reassurable although likely to present again in future	Difficult to reassure; carer and professionals may not agree on cause of symptoms and/or the need to consult or investigate further	Not reassurable; carer's objectives are diametrically opposed to those of professionals	Carer lacks insight	Carer's "illness behavior" will usually be appropriate for the signs displayed by child, but the child protection intervention may have affected the carer's behavior

(continued)

Table 5.4 (continued)

Starting point: A child is presented for medical attention, possibly repeatedly, with symptoms or signs suggesting significant illness but an appropriate clinical assessment suggests that the child's "illness" is not adequately explained by any disease. The examples below illustrate the range of possible considerations				
Example 1	Example 2	Example 3	Example 4	Example 5
Level of risk				
Seldom reaches threshold of significant harm	May be disabling: often some risk of significant harm, may be emotional or educational harm, or social isolation	High risk cases. Always some harm, often severe	May Vbe risk of harm	Risk of harm due to inappropriate child protection process and delay in correct diagnosis
Iatrogenic harm				
Possible iatrogenic harm risk	Significant risk of iatrogenic harm	Very high risk of iatrogenic harm	Hopefully low risk of iatrogenic harm	See above
Management				
Discuss concerns openly with carer. Managed primarily by reassurance. Try to address carer's needs	Discussion with carers may need to be handled very sensitively. If in doubt, discuss with appropriate colleagues. Firm reassurance. Avoid iatrogenic harm. Multi-agency assessment may be needed to gain understanding of what underpins carer behavior (either "Child in Need" or "Child at risk" referrals may be indicated)	Local Safeguarding Children Procedures apply. Take immediate steps to reduce iatrogenic harm if possible. Do not disclose concerns to carers without first discussing the case within the Safeguarding procedures	Discuss with carers whether they feel that they have any mental health needs and how those might be addressed. Consider discussing with GP or other relevant professional (bearing in mind the constraints of patient confidentiality). Carer's mental health needs must be addressed. Child may be "Child in Need"	Consult widely with colleagues if a "false positive" child abuse diagnosis seems likely. If safeguarding procedures have already been activated, an immediate strategy meeting should be requested and the situation should be discussed with carers without delay

[a] Induced illness may include inflicted injuries intended to mimic a disease, but generally physical abuse where the perpetrator denies the cause of the injury would not be included

[b] Erroneous FII diagnosis has been described in the literature and this possibility must always be borne in mind. In one follow up study by the British Paediatric Surveillance Unit [148]. None of the 97 "MSBP" cases were subsequently found to have been due to misdiagnosed genuine disease (old terminology pertained at that time)

- Unusual calmness or knowledge of illnesses
- Parents who fit in contentedly with ward life or, paradoxically, actively obstruct medical care
- Factitious or somatoform disorder in the perpetrator
- Extensive fabrication in other areas of their lives
- Fabrication of illness in spouses or pets [146]
- A history of self harm
- Complex obstetric histories that may be in part fabricated or self-induced problems [147]
- Alcohol or drug misuse
- Criminal activity
- Personality disorders including hysterical and borderline types [145]
- A personal history of being victims of child abuse or rape (which may not always be substantiated)
- A history of conduct disorder or eating disorder
- A very erratic employment record or interrupted training in a health related area
- Some engage in litigation, seek compensation, or allege harassment
- Some harass or complain about the doctor who made the diagnosis
- Financial mismanagement
- Marital and relationship difficulties, often well concealed

However, many of these features are present in carers who have not fabricated illness in their children and it would be wrong to use features such as these to support a diagnosis of FII. However, some of these are factors that must be considered in the wider assessment of risk to the child as part of the core social services assessment.

Epidemiology of FII

Studies give an estimated annual incidence of FII between 0.5 and 2/100,000 children under the age of 16 years. Figures vary according to study inclusion criteria [139, 148, 149]. The British Paediatric Surveillance Unit (BPSU) epidemiological study in United Kingdom in the early 1990s included new cases of FII, confirmed at Child Protection Case Conference or in Family Courts. There were 97 new cases identified over 2 years which suggests that a large teaching hospital will identify one or two new cases per year [139, 148]. There was no gender difference, the median age at onset was 20 months and 77% of the children were below 5 years of age. There were large unexplained variations in reported incidence between different regions in the United Kingdom.

In pediatric clinical practice, however, concerns about FII are frequently encountered because of the chronic nature of the presentations and the broad spectrum of the condition including “milder” cases that may not all require a formal child protection response. Large number of professionals may be involved in a single case.

Watson et al. quoted in [150] surveyed Primary Care Teams and identified FII concerns in almost 1 in 1000 children, most of whom had not been identified as being "at risk."

There have been a few reports of FII involving traditional healers and faith healers in developing countries [151, 152]; however, FII tends to be reported mainly from countries with well developed health services from secondary and tertiary care facilities where the clinicians can effectively join a *folie-a-deux* with the fabricating carer. The availability of investigative and treatment facilities and a defensive medical culture with a fear of missing a rare diagnosis and attracting criticism are probably important factors in its evolution. Doctors unwittingly become duped into harming the child by their tests and treatments, although the primary responsibility for the abuse clearly rests with the carers if they are deliberately deceiving the doctors.

Presenting Features

Certain medical conditions where the diagnosis rests mainly on history and there are no reliable signs or test results which would refute the diagnosis are more vulnerable to fabrication or induction than others. In confirmed FII cases, it is often apparent that when the child was first presented to doctors, the symptoms reported were vague and nonspecific. After seeing several doctors, the carer becomes more aware of the important clinical signs for the suspected condition and the history given by the carer becomes more precise and convincing. This is just one way in which doctors contribute inadvertently to the problem. Examples include fabricated seizures, apnea, allergies [153], asthma [154], vomiting, or diarrhea.

Some parents may extend the fabrication by falsifying physical signs. The commonest example is simulating blood loss, where the blood may be found to come from the carers themselves [139, 155]. It is very important that opportunities to analyze blood in these situations are not missed [156, 157]. Other examples are carers who put glucose or albumin in urine samples, falsify blood glucose measurements or oxygen saturation readings, alter ward charts, tamper with laboratory specimens, obtain stomach or bowel contents from the child and substitute for other specimens, add water to the baby's nappy to falsify an excessive diuresis, spit in the child's ear, and so on [158–160]. Falsified fever has become rare since the use of ear probe thermometers has replaced the old mercury thermometers.

The most extreme presentations merge with severe physical abuse and involve repeated smothering [161, 162] or poisoning [139], physically injuring the child to produce rashes [163, 164], administering noxious or caustic substances to various parts of the body [165–169], burning the child to mimic skin conditions [170], inserting needles into the abdominal cavity, gouging the child's ears, ligating body extremities, depriving the child of food [164], injecting feces into soft tissues or central lines to cause polymicrobial sepsis, and so on [164, 171, 172]. These behaviors are far removed from the actions of any normal parent and are very ominous in terms of mortality and morbidity.

Table 5.5 lists indicators that may help to give an overall picture and prompt more detailed investigation of the possibility of FII. The medical presentations are varied. Table 5.6 summarizes the mode of presentation documented in the BPSU study.

Smothering cases present with apnea and cyanosis, with or without associated convulsions. ALTE are relatively common clinical presentations in early childhood and only a small percentage are due to abuse [173–175]. Repeated apnea occurring only in the presence of one carer, where the infant recovers rapidly without active treatment and has no features of any underlying disease, should alert suspicions of FII [176]. Fresh blood appearing at the nose or mouth in an infant with recurrent apnea should be regarded as ominous [177–179]. Smothered infants may also have diffuse shadowing on chest X-ray and altered blood indices, particularly a lymphocytosis [162]. Where smothering is confirmed, there is often a past history of a sibling death in suspicious circumstances [161].

Fabricated seizures are particularly difficult to diagnose and commonly mismanaged. There are many reasons for this; many normal children have odd "episodes" that could justifiably raise concern about seizures. Anxious parents may to some extent "refine" the history they provide to encourage doctors to take them seriously. Carers who have a propensity to exaggerate or fabricate their child's medical history will rapidly learn that this is fertile ground to exploit this tendency. Epilepsy is a clinical diagnosis and there is no diagnostic test that confirms or refutes the diagnosis. Electroencephalography (EEG) may be normal in children with epilepsy or abnormal in children who do not have epileptic seizures. EEG therefore has its place

Table 5.5 Indicators which should alert doctors to the possibility of fabricated or induced illness (FII) may be included [210]

Reported symptoms and observed signs are not explained by any medical condition from which the child may be suffering
Physical examination and results of investigations do not explain the reported symptoms or signs
Inexplicably poor response to prescribed medication or other treatment, or intolerance of treatment
Acute symptoms are exclusively observed by/in the presence of one carer, are not seen in the absence of that carer, and subside when the carer is not present
Reporting of new symptoms on resolution of previous problems or reporting symptoms in different children in sequence
Limitation of child's daily life and activities, beyond what is expected due to any known disorder from which the child is known to suffer, e.g., partial or no school attendance; limitation of activity; special aids
Objective evidence of fabrication, e.g., conflicting history of events from different observers; history of events which are biologically implausible (e.g., small infants with a history of very large blood losses who do not become anemic, or infants with large negative fluid balance who do not lose weight); test results such as toxicology studies or blood typing; covert video surveillance
Carers may express concern that they are under suspicion of causing FII, or relatives may raise concern that the carer may be causing the child's illness
Carers who seek multiple opinions inappropriately

Table 5.6 Presenting features in 97 "FII" cases from BPSU study [156]

Presenting feature	Fabrication cases	Fabrication with falsification cases	Illness induction cases	All cases
Fits	8	4	12	24
Apparent life threatening events (ALTE)	4	1	17	22
Drowsy, coma	0	1	12	13
Blood loss in vomit or rectally	2	8	3	13
Failure to thrive, feeding difficulty	1	1	9	11
Bowel disturbance	4	2	3	9
Asthma	6	0	3	9
Vomiting, gastro-esophageal reflux	0	2	6	8
Blood loss, haemoptysis	0	2	3	5
Skin lesions	0	0	4	4
Fabricated disability	3	0	0	3
False allegations of abuse	1	0	2	3
Blood in urine	0	2	1	3
False disclosure of accidental overdose	0	0	3	3

but should be interpreted with caution if the history provided by the carer cannot be relied upon. If in doubt, anti-epileptic medication should not be offered and further attempts should be made to secure reliable history and explore wider aspects of the family's presentation. Delay in starting treatment for genuine epilepsy in children is seldom prejudicial in any way [142, 164, 180–186].

Poisoning often presents with altered consciousness [187–191]. The commonest agents used to poison children in UK FII cases are anticonvulsants, maternal psychiatric drugs, drugs of abuse, paracetamol (acetaminophen), and household agents such as common salt or bleach [139]. Poisoning with insulin or hypoglycaemic drugs are also well recognized causes of hypoglycaemia. The latter will not show the characteristically high insulin:C-peptide ratio of exogenous insulin administration [192–194]. Toxicology studies should be requested if poisoning is suspected. Both blood and urine should be sent so that both qualitative and quantitative studies can be undertaken. Salt poisoning presents with hypernatraemia [195]. Where salt poisoning is suspected, urine sodium excretion should be carefully monitored as well as plasma sodium and osmolarity. Detailed guidelines have been produced by the Royal College of Paediatrics and Child Health in the United Kingdom [196]. Insulin poisoning is rare but serious and can be identified by the high blood insulin levels and lack of corresponding elevation of C-peptide [197–200].

Gastro-oesophageal reflux (GOR) also deserves particular mention. GOR in varying degrees is universal in infancy and there is considerable debate about the association with other problems such as apnea and whether in fact GOR is causal

[174, 201]. The identification of GOR in the course of investigating recurrent apnea, persistent vomiting, or failure to thrive therefore should not prevent consideration of other possible diagnoses including FII, although FII probably accounts for only a very small proportion of persistent apnea or vomiting cases. The key, as usual, is careful history taking and clinical observation. Unfortunately, there have been many examples of cases where clinicians embarked on invasive interventions before the "penny dropped" and a diagnosis of FII was confirmed [139, 171, 200, 202–209].

Management of Suspected FII Cases

Detailed description of the clinical management of such cases and the ensuing child protection processes is contained in various other publications and is beyond the scope of this text. However, certain basic principles are worthy of emphasis (Table 5.7).

Covert Video Surveillance

This is a controversial area and is seldom needed if a comprehensive Health Chronology has been compiled and the possibility of FII considered in a multi-agency context. Covert video surveillance (CVS) would be indicated if there was no other viable way of safeguarding the welfare of the child. It is conducted by the police acting under the relevant legislation governing their investigatory powers (in the United Kingdom this is the Regulation of Investigatory Powers Act 2000) and should not be undertaken by health staff acting alone. Where it is felt that CVS may assist, it should be discussed in a strategy meeting attended by legal advisors and a senior police officer. The following circumstances might indicate that CVS would be helpful [162, 210].

- The cause of the child's illness is unexplained but FII abuse is suspected
- The prevailing evidence for child abuse is not considered strong enough to allow effective protection of the child or other children
- Other appropriate investigations have been undertaken and there is no realistic alternative investigation which may explain the child's illness
- Overt surveillance has been considered and not felt to be appropriate
- The child is having some type of "episode" of illness with a reasonable frequency (i.e., frequent enough that CVS is likely to capture an episode in a realistic timeframe)
- The "episodes" occur in hospital if the child is not closely supervised
- The location of the "event" is predictable, that is, the suspected abusive event is likely to be within the field of vision of CVS if it occurred
- The suspected act of abuse is something which is likely to be recognizable on CVS

Table 5.7 Basic principles of management of FII

Where early concerns about FII arise, it is essential that iatrogenic harm is kept to a minimum
There are several available checklists of "warning signs" for FII that may be referred to at this stage and may be helpful
Taking a very detailed history of the child's condition from all adult carers is very important as important incongruities may arise. Some family members may already suspect FII and may volunteer this information
Any further tests or opinions should be directed at attempting to confirm or exclude the possibility of FII
All clinicians involved with the child should be made aware of the concerns
It is important that all clinicians keep an open mind and avoid dividing into discrete "camps" or assuming the role of advocate for the carer. The focus must be on the welfare of the child
Inflicting harmful investigations or treatments on a child in an attempt to exclude the presence of a rare disorder is inappropriate until concerns about FII have been resolved
The carer(s) should not be alerted to the concerns in the early stages as important opportunities to confirm a diagnosis may be lost, e.g., by forensic tests or covert video surveillance (CVS). The disclosure needs to be carefully planned to minimize the risks to the child and enable important evidence to be secured
The physician needs to keep an open mind and equal effort needs to be put into confirming genuine physical disease and FII
Information should be sought from other treating centers, bearing in mind the probability that the carers may have "shopped around" for various opinions (or to evade detection) and that perplexing problems are often referred to tertiary centers that may not be well placed to address a complex child protection concern
Sometimes, the most important "test" is to see if the child's symptoms resolve when the carer is absent. This may be difficult to arrange as an abusive carer will realize that his/her deception may be uncovered and will resist this plan, so statutory agencies may have to be involved
The threshold for making a child protection referral/report is a concern that the child may be at risk of significant harm. If that concern cannot be resolved rapidly without placing the child at further risk then a referral should be made
The initial strategy meeting, held without the carer's knowledge, is crucially important in defining a way forward and all relevant agencies need to be properly represented
The focus throughout has to be on the avoidance of harm to the child
The mental health needs of the carer should also be considered and appropriate supportive services offered after disclosure of the concerns
The absence of an identified mental health condition in the carer does not undermine the diagnosis of FII in any way and it is important that an adult psychiatrist does not assume the role of advocate for the carer within the child protection process
It is helpful if one physician (usually a pediatrician) assumes the role of responsible consultant and becomes the conduit for all medical information
A detailed medical chronology should be prepared and is likely to be invaluable in clarifying what, if any, medical conditions the child suffers from

- Appropriate resources and training can be made available in order to ensure that CVS can be undertaken efficiently and safely

If there is an agreement to proceed with CVS it would be sensible to involve a clinician with appropriate experience to oversee the medical contribution to the process.

Illustrative Case *A child protection agency requested a forensic assessment of a family based upon ongoing concerns regarding the children's poor school attendance that was impacting upon their academic and social development, their failure to connect with their family and father, the children's social isolation, the number of different doctors the children had attended, the use of prescription medications for both children, and their mother's mental health. The parents were separated. The children lived with their mother but visited their father at increasingly infrequent times. The case was particularly complex requiring an assessment of each of the parents and children with specific attention to their mental health and included a developmental assessment of the children. Data for review by the assessing forensic physician and forensic pediatrician included the outcome of interviews and assessments of the parents and children, together with school reports, the results of interviews with teaching staff, and the medical records from the various treating general practitioners.*

A recommendation was made that the mother undergo a psychiatric assessment and pending this assessment that the children be removed from her care and placed into the care of their father with supervised access to their mother. Following the mother's psychiatric assessment, the children were placed into the permanent care of their father. This decision was challenged in court by the mother who presented a second psychiatric assessment indicating that she did not suffer from any mental health problem. Initially the mother was represented in court by legal counsel but she dismissed these practitioners and decided to represent herself. As the case progressed, the mother failed repeatedly to attend court and also failed to provide the court with any reasoning for her absence. A court decision was subsequently made placing the children into the permanent care of their father.

Key Points

- Physical child abuse should be undertaken by paediatricians with formal training in forensic medicine or by forensic physicians with extensive experience in paediatrics
- Physical child abuse is not uncommon and it is important to consider this diagnosis in the list of differential diagnoses for any child presenting with injuries
- The main injuries that may present in a case of physical child abuse and how this case should be assessed
- All healthcare professionals have an important role in recognizing suspected child physical abuse and need to be aware of how to make a referral to the appropriate agencies in their jurisdiction.

Self-Assessment Exercises

1. Outline the main features of the assessment of a child with suspected physical abuse.
2. List the main anatomical sites for abusive and nonabusive bruising.

3. What does a yellow discolouration about a bruise mean?
4. Is a torn labial fraenulum pathognomonic of child abuse in a young child?
5. What is the most common intentional burn?
6. What is the appropriate first-line radiological and pathological investigation of fractures?
7. What are the clinical features of abusive head trauma?
8. What are the presenting features of fabricated or induced illness?

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Chemical Crowd Control Agents

6

Sarah L. Belsey and Steven B. Karch

Learning Objectives

Interpret the symptoms and signs of exposure to chemical crowd control agents, fentanyl (and derivatives), and nerve agents.

Be able to use this knowledge to devise an appropriate treatment plan.

To understand the risk of secondary exposure to these chemicals and know the appropriate measures to take to ensure the safety of healthcare professionals.

Introduction

Chemical crowd control agents (CCCAs, also referred to as riot control agents) are a form of chemical restraint typically used to disperse and temporarily incapacitate large crowds so that smaller, more controllable groups result. The use of CCCAs also aims to minimise the requirement for physical intervention and force altogether. As such, these agents may be termed "less-than-lethal" weapons [1]. Other less-than-lethal weapons may be employed for restraint purposes, for example conductive energy devices (CEDs) such as Tasers. As CEDs are based on delivery of electricity, as opposed to a chemical, they will not be discussed in this chapter (See Chap. 8). The use of CCCAs is not limited to law enforcement personnel. They may be used by the military as training agents, as well as by civilians for self-defence. CCCAs may also be used by terrorists to incite fear or panic in the public. Delivery

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of CCCAs can be targeted at specific individuals using spray or pellet formulations, or to target groups through use of canisters, grenades, or water cannons [2].

An effective CCCA should have rapid onset of effects (seconds to minutes), a relatively short duration of effects, and a high safety ratio (i.e. a high ratio of the estimated lethal dose to the effective dose) [3]. The effectiveness of any agent depends upon the correct delivery to an appropriate area of the body, for instance the application of capsicum to the back is not going to deter anyone. One of the greatest challenges in the safe use of CCCAs is deployment of these agents in confined spaces, where it is not uncommon for officers themselves to be exposed to the agent whilst trying to make an arrest.

Numerous chemicals are used for riot control and law enforcement purposes (Fig. 6.1). The most commonly available CCCA is chlorobenzylidene malononitrile (CS, 'tear gas'), which replaced chloroacetophenone (CN, 'mace') due to a better toxicity profile [4]. Dibenzoxazepine (CR) was synthesised later in 1962, and is more potent and less toxic than both CS and CN [5]. For large crowds, 'bombs' have been developed that can be dropped from aerial positions producing wide dispersal of these compounds. They are also formulated in grenades or canisters, which can be propelled by either throwing or with a projectile device. Oleum capsaicin (OC; 'pepper spray', PS) is the only naturally occurring CCCA and contains a mixture of chemicals derived from chilli peppers, with capsaicin the major component present. The exact composition of OC is determined by various factors such as ripeness of the chilli, the environment in which the plant is grown, and the method of extraction [6]. It should be noted that some pepper spray formulations contain a combination of CS and OC. A synthetic analogue of capsaicin, pelargonic acid vanillylamide (PAVA; nonivamide), may also be used as an incapacitant/irritant spray. The advantage of PAVA over OC is that it is a single compound which makes its toxicological profile easier to assess. Commercially available OC products lack standardisation for capsaicinoid content which leads to variation in potency between products and hence a difference in effectiveness. Incapacitant sprays are typically less potent that the gas itself, for instance CS spray typically contains 1–5% CS dissolved in methyl isobutyl ketone (MIBK) [7]. The UK spray contains 5% CS dissolved in MIBK,

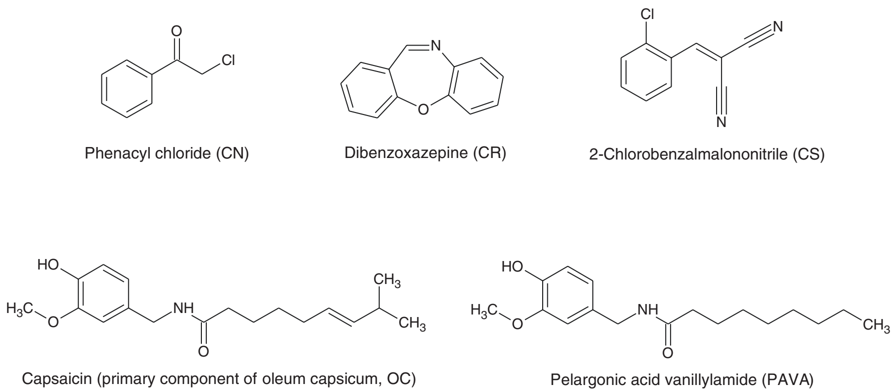

Fig. 6.1 Structures of some chemical crowd control agents

released in a 50 mL burst whereas the US spray contains only 1% CS dissolved in MIBK, released in a 10 mL burst, a 25-fold smaller dose [8]. Examples of different spray formulations are given in Table 6.1.

When used appropriately, CCCAs have a demonstrated high safety margin and generally do no permanent harm. However, toxicity can still occur. Adverse side effects are usually seen if a person has been exposed to the chemical in a closed space, if they have had repeated exposure to the chemical, or if they have been exposed to greater concentrations than normal. CCCAs may also be misused, which may result in more pronounced toxicity. For example, a reported incident in the USA detailed how law enforcement officers directly applied OC liquid via a cotton-tipped applicator to the periorbital area of protesters who refused to disperse [12]. Litigation was the predictable result and so was the court verdict; a unanimous federal jury ruling that officers had used excessive force, a clear violation of the prisoner's Fourth Amendment rights.

The effectiveness of a CCCA is not only dependent on the correct application of the agent, but can also be influenced by uncontrollable factors such as the weather (particularly wind) and whether an individual is intoxicated (with alcohol or illicit drugs). For example, PAVA is deemed to be less effective against those under the influence of alcohol; however, no published data exist to support this theory.

No discussion of chemical crowd control agents would be complete without at least some acknowledgment of more lethal methods of chemical control. The use of fentanyl derivatives as chemical incapacitants was investigated, originally by the military during the Cold War. Research into many of these derivatives stopped due to the incapacitating dose not being sufficiently lower that the lethal dose. Structural modifications (e.g. lofentanyl was derived from alfentanyl) and combination with other drugs were researched to decrease the potency of the drug and improve the safety ratio. To complicate matters, many of the studies were conducted in rodents where some safety ratios were deemed acceptable, but later studies in primates showed much lower safety ratios [13]. The main mechanism of fatal opioid overdose is respiratory depression. Clinical features of opioid toxicity include respiratory depression, CNS depression, and miosis. Administration of naloxone ('Narcan')

Table 6.1 Examples of incapacitant sprays available

Name	Irritant	Solvent	Propellant	Reference
United Kingdom				
CS spray	5% CS	MIBK	Nitrogen	[9]
Captor I	0.3% PAVA	50% aqueous ethanol	Nitrogen	[9]
Captor II	0.3% PAVA	Monopropylene glycol, water & ethanol	Nitrogen	[9]
United States				
Punch II M-3	5% OC	Not stated	Hydrocarbon	[10]
911 Pepper Spray	10% OC	Not stated	Not stated	[10]
Total Control International Pepper Spray	5% OC	92% trichloroethylene	Nitrogen	[11]

will reverse overdoses; however, higher dosing and prolonged infusion may be required due to the higher potency of fentanyl and its derivatives as compared to morphine [14].

On October 26, 2002, Russian Special Forces pumped an undisclosed incapacitating agent into the ventilation system of a Moscow theatre where Chechen terrorists had been holding over 800 people hostage for 3 days. The plan, as best as can be determined, was to disable the terrorists by exposure to a fentanyl derivative, while at the same time administering the antidote naloxone to the prisoners. Whilst supplies of naloxone had been increased, the medical services did not have the information of the chemical used which resulted in naloxone not being administered in a timely manner, and many of the captives died from opiate toxicity [15]. In part, this was due to the Russian government not immediately disclosing the use of a fentanyl derivative which led to medical personnel incorrectly treating patients as the use of a nerve agent was suspected [16]. The specific fentanyl derivative used has never been confirmed by the Russian government, but residue analysis from the hostages clothing suggests it was a combination of carfentanil and remifentanil [17].

Mechanism of Action

Capsaicin present in OC selectively stimulates nociceptors, notably TRPV1, in exposed mucous membranes [18, 19]. Exposure to OC leads to the release of substance P, bradykinin, histamine, and prostaglandins. The physiologic effects of these mediators result in vasodilation, increased vascular permeability, pain, and altered neurotrophic chemotaxis.

The mechanism of action of CN and CS is not fully understood. One proposed explanation is that hydrochloric acid is produced through reduction of chloride ions on mucosal membranes [20]. In addition, both CN and CS are SN_2-alkylating agents and readily react with nucleophilic sites such as thiol and sulfhydryl groups present in enzymes (e.g. lactic dehydrogenase, glutamic dehydrogenase, pyruvic decarboxylase). Inactivation of these metabolic enzyme systems may be related to the tissue injury that occurs following exposure [21]. CN and CS have also been found to interact with the TRPA1 receptor family. These receptors belong to the transient receptor potential (TRP) family of cation-selective channels that convert mechanical, thermal, and pain-related inflammatory signals, such as those that result from exposure to ‘tear-gas’ agents, into transmissible pain nerve signals [22].

Clinical Effects and Treatment

CCCAs produce a wide variety of physiological effects, with the most common clinical findings being pain, burning, and irritation of exposed mucous membranes and skin (Table 6.2). Individuals suffering from the acute effects of CCCAs should immediately be brought into fresh air. The initial treatment protocol should involve decontamination, including removal of contaminated clothing. Copious irrigation of

Table 6.2 Common clinical findings with exposure to crowd control agents

Finding	CS	CN	OC
Ocular			
Lacrimation	✓	✓	✓
Blepharospasm	✓	✓	
Pain and/or burning	✓	✓	✓
Conjunctival injection	✓	✓	✓
Conjunctival oedema	✓	✓	
Photophobia	✓	✓	
Corneal abrasion	✓	✓	✓
Impaired vision	✓	✓	✓
Upper airway			
Pain and/or burning	✓	✓	
Shortness of breath	✓	✓	✓
Increased secretion	✓	✓	
Congestion	✓		
Coughing	✓	✓	✓
Throat irritation	✓	✓	✓
Wheezing	✓	✓	✓
Irregular respiration[a]	✓	✓	
Dermal			
Pain	✓	✓	✓
Contact dermatitis		✓	✓
Blistering	✓	✓	✓
Miscellaneous			
Nausea/vomiting	✓		
Bad taste	✓		
Headache	✓		
Increased blood pressure[a]	✓		

[a]Initial response thought to be associated with pain

the affected areas should attenuate the burning sensation [23]. However, care must be used to prevent contaminating other sites with the irritant (e.g. washing OC from the hair into the eyes or the oral pharyngeal mucosa). Serious systemic toxicity is rare and occurs most frequently with CN; particularly when used in very high concentration within a confined non-ventilated space.

Secondary exposure to CCCAs could be a notable occupational hazard for health care workers. It is therefore important that medical personnel should take precautionary measures such as wearing impermeable gloves and goggles while dealing with these patients. The patients should be asked to remove any clothing and to seal it in a plastic bag in order to prevent secondary contamination [23]. Effects may be minimised with common sense practicalities, such as decontamination prior to an individual being placed into a confined area such as a police car, ambulance, or treatment room in hospital. The Faculty of Forensic and Legal Medicine (FFLM) publish recommendations for forensic physicians, custody nurses, and paramedics on the clinical effects and management of incapacitant sprays [24].

Treatment of exposure to CCCAs is summarised in Table 6.3. Whether the effect of CCCA exposure amongst those with underlying health conditions (e.g. asthma, chronic pulmonary obstructive disease) is more severe is an unknown. Current research on the topic remains equivocal, and is hindered by the fact that many studies have been conducted solely in animal models or small groups of healthy human volunteers. Reports of CS exposure in a nightclub [25] and in Londonderry [26] indicated patients with asthma experienced no greater sensitivity. However, a study in South Korea reported that patients with asthma and chronic obstructive pulmonary disease experienced deterioration of lung function following CS exposure [27]. Further research has been suggested by The UK Department of Health to investigate whether individuals with hypertension or cardiovascular disease, as well as those taking neuroleptic medication, may be more susceptible to the effects of CS [28].

Ocular Toxicity

The most sensitive target organ of CCCAs is the eye. Ocular toxicity resulting from exposure to CCCAs ranges in severity from conjunctival erythema/oedema to ocular necrosis. More severe toxicity is usually due to CN exposure. The most typical findings are lacrimation, conjunctival erythema/oedema, blepharitis, and erythema [29]. A retrospective study of 81 patients who presented to the emergency department as a result of OC exposure showed 56% developed opthalmodynia, 44% conjunctivitis, 40% conjunctival erythema, 13% lacrimation, and 9% corneal abrasion [30]. More severe findings are often found in exposure victims who wear contact lenses [31]. Soft contact lenses should be disposed of as OC residue has been shown to remain even after cleaning of the lenses [32].

There are conflicting views regarding irrigation of the eyes after CS exposure. Some suggest that the eyes should be thoroughly flushed with water or saline for 10–20 min [25, 33], while others advocate blowing dry air directly onto the eye to vaporise any dissolved gas [34–36]. Based on the limited evidence, irrigation with water or saline after exposure is recommended.

Table 6.3 Options for treatment for exposure to chemical crowd control agents

Treatment	CS	CN	OC
Removal of contaminated clothing	✓	✓	✓
Ocular irrigation		✓	✓
Dermal irrigation	✓	✓	✓
Alkaline solution irrigation of skin	✓	✓	
Soap and water decontamination	✓	✓	✓
Topical steroids for dermatitis	✓	✓	✓
Systemic antihistamines for dermatitis	✓	✓	✓
Systemic steroids for dermatitis	✓	✓	✓
Topical antibiotics for corneal abrasion	✓	✓	✓
Cycloplegics	✓	✓	✓
Analgesics for pain	✓	✓	✓

A slit lamp examination of the anterior chamber, including evaluation under the lids, is warranted for those with persistent ocular complaints. If particles have become embedded in the cornea or under the lids, they should be removed. If corneal abrasions are present, a few days of topical broad-spectrum antibiotics, cycloplegics, and analgesics should be applied. An example of rather severe OC dermatitis and ocular swelling is shown in Fig. 6.2. This particular patient was sprayed during arrest by police officers and brought to the hospital for evaluation. He was treated with irrigation, systemic antihistamines, and steroids with resolution of his symptoms within 4 days.

Respiratory Toxicity

Inhalation of CCCAs may cause coughing, chest tightness, and shortness of breath due to burning and irritation of the airways [29]. Improvement will immediately be seen when an individual is removed from the contaminated environment. The majority of respiratory tract symptoms and signs should resolve within 15 min of the exposure. If symptoms persist, patients should be evaluated for hypoxia with pulse oximetry or, if severe, arterial blood gases. Bronchospasm may be treated with inhaled β_2-agonists, steroids, and aminophilline [29]. Pulmonary oedema may be delayed for 12–24 h after exposure, suggesting a need for follow-up radiographs

Fig. 6.2 Periocular swelling and facial contact dermatitis from OC exposure during an arrest by law enforcement

[31]. Delayed onset bronchopneumonia may also occur from prolonged exposure to CCCAs in enclosed spaces [37].

A cluster of adverse respiratory effects associated with CS exposure during a US Marine training exercise has been reported [38]. Nine Marines were exposed to CS gas and participated in rigorous exercise within 3–4 days after the exposure. All were hospitalised with various pulmonary symptoms including cough, shortness of breath, hemoptysis (N = 5), and hypoxia (N = 4). All symptoms of respiratory distress abated within 72 h, and all had normal lung function 1 week after CS exposure.

Single case reports of severe reactions to pepper spray have been published. One detailed respiratory distress that necessitated extracorporeal membrane oxygenation in a 4 week old infant after a 5% spray was accidentally discharged in his face [39]. Another case detailed an 11 year old child who intentionally sprayed and inhaled PS from an individual canister and developed reversible wheezing [40]. These case reports are anecdotal in that they report symptoms temporally related to PS exposure and demonstrate that when used improperly these compounds can cause severe symptoms.

Dermal Toxicity

Burns occurring following exposure to CS gas are multifactorial in aetiology: (1) chemical burns caused by *o*-chlorobenzylidene malonitrile itself, (2) contact burns caused by direct contact with the hot canisters, or (3) flame burns caused by explosion of the tear gas grenades near victims. Dermal irritation in the form of burning and blistering can be treated with irrigation, preferably with an alkaline solution other than sodium hypochlorite (household bleach). The combination of bleach with CS has been noted to cause a much more severe reaction than that produced by CS alone [29].

Erythema can be common in skin that has been freshly abraded but resolves 45–60 min after exposure. Contact dermatitis can be effectively treated with topical corticosteroids and/or antihistamines such as diphenhydramine. Typical dermatitis associated with CS exposure resolves within a few days [41].

Safety

In some cases harmful effects are not due to the CCCA itself, but as a result of solvents and/or carriers, or through impact injuries caused by the delivery system (i.e. cartridges). Methyl-isobutyl ketone (MIBK) is a common solvent used in CS sprays, though there has been much debate over the safety of these formulations. MIBK is absorbed dermally and is of low oral toxicity. However, prolonged dermal contact may cause irritation, defatting of the skin, flaking and peeling. Dizziness, headache, drowsiness, ataxia, nausea, vomiting, weakness, and loss of appetite have also been reported after exposure. A study by Euripidou et al. [8] concluded that CS formulated with MIBK was more harmful than other CS formulations and exposure resulted in a higher incidence of dermatitis and blistering. Holopainen et al. [11] described 4 individuals who developed deep corneal and conjunctival lesions that took weeks to months to resolve after pepper spray exposure (formulated with 92% trichloroethylene as the carrier). In one of these cases the individual was only exposed to the solvent without the OC, suggesting that it may be the solvent responsible for the adverse effects.

A higher proportion of severe injuries have been observed when CS and OC are used in projectile munitions (27%) as opposed to in either a spray (7%) or aerosol (12%) formulation [2]. Incorrect delivery of an agent (e.g. being fired at very close distances or pointed directly at a person's face or head) may cause mechanical injury which, although rare, may lead to a fatal outcome [42]. Several factors may play a role in CCCA-related deaths including; drug use, especially that of stimulants such as cocaine and metamfetamine (methamphetamine), acute behavioural disturbance/excited delirium, and the prone maximal restraint position (PMRP) also known as the hog-tie or hobble restraint [3]. Strange as it seems, it is possible to force a body where asphyxia secondary to physical restraint occurs (such as officer placing too much weight on the back), but this does not occur in methamphetamine abusers with excited delirium who are sprayed with OC [43].

Of concern are reports describing violent prisoners, many of which were chronic stimulant users, who died after being sprayed with pepper spray [44]. In most cases where harm is alleged to have resulted from the application of chemical incapacitants, the decedents have other recognised risk factors for sudden cardiac death (e.g. ventricular remodelling, cardiomegaly) which may cause death in those not exposed to an incapacitant [45]. Many of these reports are anecdotal thus it is difficult to draw much evidence from them. Nonetheless it is important that prisoners are monitored and evaluated by healthcare professionals to minimise the risks whilst they are in custody. The absence of any association between restraint, asphyxia, and OC exposure has been demonstrated in a randomised, cross-over controlled trial where volunteers were sprayed with OC while restrained in a prone position [46]. Results from 35 individuals exposed to OC or placebo showed that inhalation of OC did not result in abnormal pulmonary function, hypoxemia, or hypoventilation when compared to those exposed to placebo, in either the sitting or maximal restraint positions. A problem with the use of CCCAs is that they are indiscriminate and affect not only the intended targets but also peaceful bystanders, nearby residents, and law enforcement officers themselves. Children and the elderly are particularly vulnerable to the toxicity of CCCAs and as a result may have worse clinical outcomes [2].

Legality

The Chemical Weapons Convention (CWC) came into effect on 29th April 1997. As of April 2016, 192 states, representing over 98% of the world's population, are party to the CWC. The CWC outlines three classes of controlled substances (Table 6.4). The CWC defines any CCCA as, "any chemical not listed in a Schedule, which can

Table 6.4 Controlled substances according to the Chemical Weapons Convention

Schedule	Use	Example
1	Few or no uses outside chemical weapons	Nerve agents
2	Legitimate small-scale applications	Thiodiglycol (used in manufacture of mustard gas, but also as a solvent in inks)
3	Large-scale uses apart from chemical weapons	Phosgene

rapidly produce in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure" [47]. The convention prohibits military use of CCCAs, and states they may be used for "law enforcement including domestic riot control purposes".

Legal availability to law enforcement and the general public differs between countries; however, most can be easily obtained through international markets or ordered on the internet from a country where use is unregulated. Law enforcement agencies should also be briefed on responsible usage and the importance of not using highly concentrated solutions of these CCCAs. Use of CCCAs by the general public comes with no education, and as a result may lead to a greater risk of adverse effects due to inappropriate use of the agents.

Nerve Agents

Although not technically classed as CCCAs, nerve agents are the most toxic and fast-acting substances known in chemical warfare and may be used to target individuals or groups. Many of these agents were developed during the Cold War, including G-series agents (e.g. Tabun (GA), Sarin, Soman, GF), and the second generation more effective V-series agents (e.g. VX). A notable feature of the V-series agents is that they do not degrade easily and can remain active on surfaces for weeks to months [48]. As a result of their persistence and potency, people exposed to V-series agents are themselves a danger to first responders who may fall ill when they come into contact with minute traces of the agent. The victims must be decontaminated and affected areas cordoned off until they can be made safe. The so-called 'Novichok' agents were designed to be more lethal and more difficult to treat than the V-series agents, with Russian scientists claiming some variants were five to eight times more potent than VX [49]. Nerve agents have been implicated in assassinations and terror attacks, perhaps most notable was the Tokyo subway attack in 1995 where bags containing sarin were punctured and left on the train floor for the vapours to disperse. The attack resulted in 13 deaths, and thousands injured.

Exposure is generally via inhalation orabsorption via the skin, but in liquid form these agents can also be released into water supplies or added to food and drink, which delays the onset of their effects. The toxidrome depends on the route of absorption; after dermal absorption muscle twitching occurs first, whereas after inhalation breathing difficulties are first apparent. The onset of symptoms after inhalation is within 5 min, but with dermal exposure can be up to several hours after exposure [50].

The clinical effects of nerve agents are a result of the inhibition of acetylcholinesterase (AChE) which causes the neurotransmitter acetylcholine to accumulate in the body. Nerve agent toxicity affects all organ systems leading to a multitude of signs and symptoms which may cloud the clinical picture and patients often present in extremis quickly after exposure. Common clinical presentation may include defecation, urination, muscle weakness, miosis, bradycardia, emesis, lacrimation, and salivation. The binding of acetylcholine at nicotinic receptors results in muscle twitches, cramps, weakness, paralysis, and areflexia. Acetylcholine can also stimulate the brain where it can induce seizures and coma.

There are no readily available assays for the clinician to use to gauge exposure levels. Measurement of erythrocyte AChE levels best indicates the severity of an acute exposure; however, this test may not be available in all hospitals or laboratories. The effects of nerve agent toxicity may be reversed through timely administration of pralidoxime (2-PAM) or obidoxime, which enable regeneration of active acetylcholinesterase. Oximes are typically administered in conjunction with atropine which blocks muscarinic acetylcholine receptors slowing down the effects of the poison. Seizures are generally best treated with benzodiazepines.

Key Points

- The aim of chemical crowd control agents is to produce temporary incapacitation of an individual or a group without the need for physical force.
- Education of law enforcement officers is important to ensure these agents are used judiciously and in the correct manner to minimise adverse effects.
- Medical care should never be withheld from those who request it, or detainees/prisoners, complaining of lingering effects.
- Whilst use of these agents is relatively benign, there are reports of serious toxicity typically when these agents have been used at high concentration, in confined spaces, or through prolonged exposure.
- It must be recognised that their use is not always appropriate and may not be effective for all individuals, e.g. the acutely psychotic.
- Fentanyl (and its derivatives) and nerve agents are more lethal chemicals which may be used to target a crowd. Timely treatment of individuals exposed to these agents is paramount to a successful clinical outcome.

Illustrative Cases

A 21-year-old military police officer candidate reported left eye pain and redness after being exposed to pepper spray to the face during a drill. Immediately after the exposure, he experienced blurry vision and mild photophobia in both eyes. His eyes were immediately irrigated with normal saline by medical technicians on site and the officer reported feeling much better, but later that evening he began to experience pain in his left eye. Two days after the exposure, he presented to the Emergency Department complaining of continued left eye pain, now with redness. Slit-lamp examination with fluorescein stain revealed a corneal ulcer that measured 1 mm × 4 mm in size. He was treated with topical erythromycin and made an uneventful recovery [51].

On October 26, 2002, more than 120 hostages held at the Moscow Dubrovka Theatre Center by Chechen rebels died during a rescue attempt by Russian military. Russian physicians were told that an anaesthetic gas had been pumped into the theatre, but the gas was not identified. Doctors presumed that a nerve agent had been used, but there were many signs of opiate poisoning. The first few hours were spent testing various antidotes before they found something that worked, Narcan. Four days later Russian government confirmed a fentanyl derivative was the drug used, the exact drug was not specified. The bioavailability of aerosolized fentanyl base is comparable to the bioavailability to intravenous administration at the same dosage. The actual drug used has never been disclosed; initially it was widely believed to be a mixture of carfentanyl and remfentanyl. Carfentanyl has 1000 times the potency of heroin. The strategy used by the Russians made sense theoretically as the therapeutic index of carfentanyl is 10 times greater than heroin, and the concentration of aerosolized carfentanyl should, in theory have been quite low. It appears that the intra individual variation between individuals rules out the use of CCCAs [15].

The Tokyo subway sarin attack was the first large-scale disaster caused by a nerve gas. A religious cult released sarin gas into subway commuter trains during morning rush hour. Thirteen passengers died and about 5500 people were harmed. Sarin is a highly toxic nerve agent chemically similar to organophosphate pesticides. It can be fatal within minutes to hours. It causes the clinical syndrome of cholinergic hyperstimulation by inhibition of the crucial enzyme acetylcholinesterase. It is the most volatile of all the nerve agents making it the most dangerous. Death can occur within minutes to hours. Therapy of nerve agent toxicity is divided into three categories, decontamination, respiratory support, and antidotes. All of these therapies may be given simultaneously. Because most of the hospital staffs had no training many (23%) suffered acute poisoning themselves due to secondary exposure. The episode illustrates the need for multi-level, coordinated, disaster drills and the need for mass casualty planning [52].

Self-Assessment Exercises

1. List the signs and symptoms of ocular toxicity following exposure to a chemical crowd control agent.
2. Outline the measures you should take to protect yourself from secondary exposure to chemical crowd control agents.
3. Outline the treatment plans for (a) an individual exposed to fentanyl (or a derivative), and (b) an individual exposed to a nerve agent.

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Medical Issues Relevant to Restraint

7

Philip S. L. Beh and Margaret M. Stark

Learning Objectives

Understanding of legislation and basic principles underpinning the use of force.

Discuss the use of Use of Force Continuum.

Describe and interpret the injuries that may result from the use of force.

Introduction

In this modern era and in places where there is a functioning government with a robust judicial institution, the clash between individual rights and demands and those of the state or institutions will occur and will be subject to often intense public scrutiny. Readers will have watched television news broadcasts of large-scale protests and demonstrations at meetings of World Trade Organizations, Climate Change Summits, etc.

This chapter makes no attempt at answering what the norms or limits should be in the interaction between police and such demonstrators but will look at the various medical issues that such interactions between the police and the public may give rise to, and in particular, what the healthcare professional (HCP) called in to examine and record evidence of such encounters should be aware of so as to enable them to perform a thorough and detailed examination and to draw conclusions that can be supported by medical evidence.

The HCP's involvement with these issues involves many of the core attributes needed in the practice of high-quality forensic medicine. These include the need for good history taking from as many involved parties as is practical to clearly establish

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events, and a precise examination recorded clearly and contemporaneously. Objectivity must be maintained in the light of differing histories, and there is a need to keep abreast of developing restraint techniques and use of force, e.g. the introduction of spit and bite guards (SBG) which may bring new clinical problems. However careful police officers may be, there is the potential for serious injury requiring further medical intervention, and the real possibility of being a witness in a legal process such as police disciplinary procedures.

Legislation & Statistics

The law on the use of force varies depending on the jurisdiction [1]. The use of force should be based on the principles of necessity and proportionality. As a general principle during restraint, any force used must be proportionate to the threat faced, be lawful, and necessary in the particular circumstances. The United Nations have produced guidance for Law Enforcement Officials. In 1979 the Code of Conduct for Law Enforcement Officials [2] and in 1990 Basic Principles on the Use of Force and Firearms by Law Enforcement Officials [3].

The Human Rights Act 1998 (HRA) in the United Kingdom requires all public authorities, including the police, to act in a way which is compatible with the European Convention on Human Rights (ECHR). Use of force may engage several of the ECHR Articles: 2 Right to Life; 3 Prohibition of Torture; 5 Right to liberty and security; and Article 8 Right to respect for private and family life. The use of force by police must also be balanced against Article 11 Freedom of assembly and association.

Illustrative Case *M and about 100 others were kettled at a protest. No one disputed the confinement as there had been serious damage and a breach of the peace of which the police believed the recurrence was likely. As the group was funnelled slowly out, the chief superintendent decided that each of them should be filmed giving their personal details on camera as this would help the police with any subsequent investigations. M was taken to a separate area surrounded by officers, filmed and asked to state her name, address and date of birth. She asked which police powers authorised this action. She was not answered until after the filming. The court found that there were no statutory powers that allow the police to take details and film before the persons were allowed to leave the confinement. As such the giving of information and consent to filming had to be voluntary, which was not the case here. Therefore there was a breach of Articles 5 and 8 and the film should therefore have been destroyed*. [Mengesha v Commissioner for the Metropolis 2013].

In the England and Wales the three main powers relating to the use of force are contained within:

- common law
- section 3 of the Criminal Law Act 1967
- section 117 of the Police and Criminal Evidence Act 1984 (PACE).

In Northern Ireland (NI) the equivalent legislation is section 3 of the Criminal Law Act (Northern Ireland) 1967 and Article 88 of the Police and Criminal Evidence (Northern Ireland) Order 1989. The question whether the degree of force used by an officer was reasonable in the circumstances is to be decided by reference to the circumstances as the officer believed them to be at the time of making the arrest under Section 76 of the Criminal Justice and Immigration Act 2008.

In the United States an important case is that of *Graham v Connor* [4]. The Supreme Court clarified the basic US legal standard for determining the legality of any use of force by a law enforcement official in 1989 as whether his or her actions were 'objectively reasonable'. This assessment must be made on the perspective of a reasonable officer on the scene including what the officer knew at the time.

Comparatively recently (April 2017) in the UK the National Police Chiefs' Council (NPCC) has introduced a requirement for all police forces in the UK to record data on 'police use of force'. The Home Office released a set of 'experimental statistics' in December 2018 on the police use of force in England and Wales [5]. The police use of force 'refers to an officer using a force tactic (from handcuffing to using a firearm) on an individual'. A 'use of force incident' refers to one officer's use of force on one person. This means that situations involving more than one officer will count as multiple incidents.

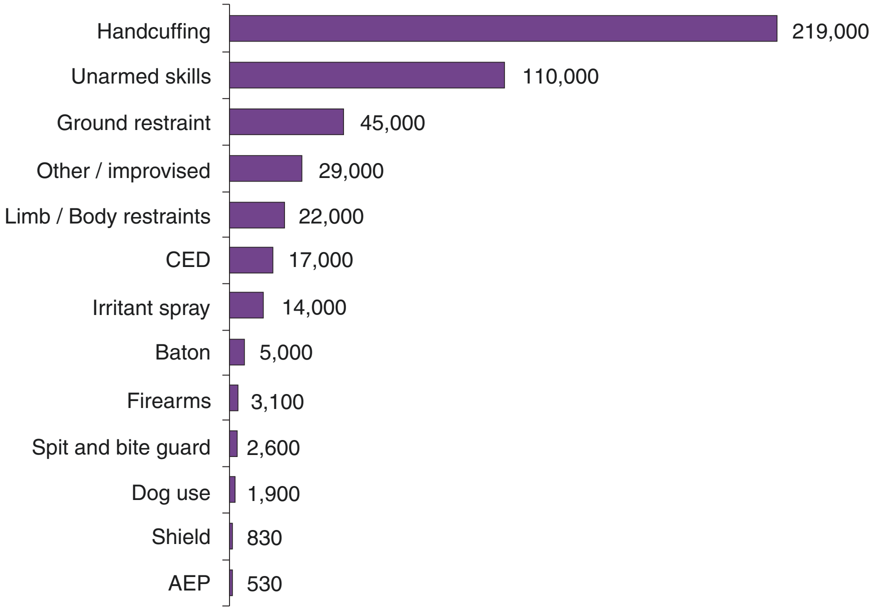
There are 43 police forces in England and Wales and over the period of 1 April 2017–31 March 2018 there were 313,000 recorded incidents with 469,000 force tactics used. These figures are not an accurate representation of the total number of incidents and not all forces provided full data. Handcuffing was the most common with unarmed skills next most frequent (Table 7.1) and other restraint tactics less common; examples of types of use of force are given in Table 7.2.

After arrest when the individual has been taken into police custody there is an expectation that 'any force used is strictly necessary, proportionate and lawful, used as a last resort and subject to robust accountability' [6]. If force is used in the custody setting it should be carried out by trained staff using approved techniques and for no longer that necessary. Staff should be trained in effective de-escalation techniques.

The restraint process maybe particularly challenging where the person has a mental health problem or is intoxicated with drugs and/or alcohol. In addition, the officer must be able, in retrospect and maybe under close scrutiny, to demonstrate that his/her actions were entirely appropriate. The National Decision Model [7] can assist police officers in making these complex decisions. The six key elements include a Code of Ethics covering the principles and standards of professional behavior; information and intelligence gathering; assessment of threat and risk and development of a working strategy; consideration of powers and policy; identify options and contingencies; and take action and review what happened. It must be recognized that at the time of restraint, officers may not have the luxury of time for a full analysis using prior information, or the knowledge that experience, combined with extensive training and re-training, brings.

In recent years police have started to use body worn cameras (BWC) that record the interactions with the public. Researchers have looked at whether BWC reduce the prevalence of the use-or-force and/or citizens' complaints against the police and

Table 7.1 Number of times tactics were used in use of force incidents, England and Wales, year ending March 2018



Source: Home Office, Police use of force statistics, England and Wales, April 2017 to March 2018, Table 1.
The number of tactics does not sum to the total number of incidents as multiple tactics can be used in an incident.
The tactic 'CED' refers to a conducted energy device (i.e TASER®)

Table 7.2 Examples of use of force

• Rigid handcuffs
• Plastic wrist restraints/Body cuffs
• Spit hoods
• Irritant spray—CS & PAVA
• 'Empty hands'—unarmed combat
• Batons
• Personal Protective Equipment (PPE)/Shield
• Conducted Electrical Device (CEW)
• Prone restraint
• Water cannon
• Attenuating energy projectiles (AEP)
• Dogs
• Horses

initially found that the use of force was reduced as was the number of complaints filed against police officers [8]. However more recent research in a variety of jurisdictions have found that there was no overall discernible effect of using BWVs on police use of force and there was an increased likelihood of an officer being assaulted during a shift compared to not wearing the cameras [9]. Further research is needed to evaluate the use of BWC.

As an independent HCP, excellent clinical management throughout the case enables the HCP to act as a high-quality witness if needed. The HCP also has a duty to report any instance where excessive restraint appears to have been used and such concerns should be communicated to the senior police officer on duty immediately. The HCP needs to be aware that equipment may be misused so that a long barreled metal torch could be used as a striking weapon in some circumstances and indeed such lights were withdrawn in the United States to prevent this happening.

Illustrative Case *A 21 year-old male was under arrest regarding an allegation of possession of drugs. The HCP was called to document the detainee's injuries. The detainee complained of sore wrists. He advised that he had been handcuffed, resisted, and been put on the floor by police, the handcuffs had tightened. He described having a hand and arm across his neck; he said he was elbowed in the neck and had a knee put on his neck. He couldn't breathe or speak. There was no loss of consciousness and no urinary incontinence. He had no pain or difficulty in swallowing now.*

The HCP noted the following injuries:

1. *Inside the mouth there were injuries to both inner cheeks:*
   (a) *On the right side at the front of the inner right cheek at the level of the lower teeth a 2 cm linear abrasion*
   (b) *On the left side at the rear of the inner left check at the level of the lower teeth a 2 cm linear abrasion*
2. *An area of petechial haemorrhage or pinpoint bruising to between the eyebrows, round both eyes and below both eyes. The 'whites' of the eyes (sclerae) were reddened.*
3. *An abrasion of 1 cm by 0.5 cm to the left upper neck just below the angle of the jaw.*
4. *Three areas of patterned bruises to the right side of the neck one of 0.5 cm × 1 cm and two of 1 cm × 1 cm.*
5. *Extensive reddening round both wrists:*
   (a) *On the outer aspect of the right wrist over 5 cm in length with a 1.5 cm abrasion on the outer border and over 7 cm in length on the inner aspect of the wrist*
   (b) *On the outer aspect of the left wrist 6.5 cm in length with three linear abrasions - one of 1 cm and two of 0.5 cm; and on the inner aspect of the wrist over 5 cm in length with a 1 cm abrasion.*
   (c) *There was also a 2 cm incised wound on the back of the left wrist.*

The HCP concluded that the injuries to the wrists are typically seen with the application of rigid handcuffs. The petechiae seen to the face with the reddened 'whites' of the eyes are typical of compression to the neck. Bruises and abrasions may be seen on the front and sides of the neck as a result of the compression and the pattern of skin surface injuries may be difficult to interpret because the dynamic nature of such an assault and the possibility of the repeated re-application of pressure during strangulation. There may be damage to the mucosa of the mouth and tongue due to direct pressure on the teeth internally as seen in this case. The HCP spoke to the duty inspector about the findings of petechiae over the face.

The Use-of-Force Continuum [10]

Police forces around the world will have policies and guidelines for their officers on when and how much force they can legitimately use in the line of duty. These will vary, but in the US research has shown that most use of force occurs in a linear fashion [11], where there is escalation from mere officer presence to more severe types of force. Individual police forces are likely to have their own guidelines but it is likely that they will include some or most of the following:

Officer presence—The simple presence of uniformed officers at an incident may be an effective means of establishing order. Such presence may vary from a single officer at petty disputes to large numbers of teams of police officers in riot gear, in armored vehicles, and in some jurisdictions even mounted police officers and officers with specially trained dogs; when such presence results in amicable outcomes, all involved are contented.

Verbalization—Here officers may need to shout or broadcast warnings to an individual or to crowds. Again, where consensus can be reached, it will gain a satisfactory outcome.

Empty hand control—From this point on there is physical contact between the officer and a member of the public. The outcome of such an encounter often depends on the degree of force used by the officer as well as on the degree of resistance put up by the person that the police officer has identified for "control". For example, in a situation where protesters lie on the street and allow the police to lift and remove them without any resistance, no or minimal injuries are expected. On the other hand, if an officer had chased and tackled a person running, one may expect to find injuries on both the officer and the subject. In some jurisdictions, officers are allowed to punch or kick to restrain an individual. In such instances the presence of injuries from such punches or kicks are of course to be expected.

Non-lethal force—Here officers will be using force in responding to an individual. Such non-lethal force will often involve the use of:

Batons—Batons come in different forms from the almost iconic wooden baton to longer extendable metallic tubes, etc. Essentially, police officers would have received training on the use of such "weapons" and in particular on where and how to strike individuals to disarm them and or to inflict sufficient pain to allow for the police officers to restrain such individuals.

Up to the early 1990s, UK police officers were equipped with a short wooden truncheon about 40 cm long and weighing just under 300 g. There was little formal training with these weapons but actual usage was not that common, either because they were not terribly effective or the situations faced at that time could be dealt with in different ways. In 1993, trials of both side-handled and a number of straight batons were introduced, as there was a rise in the number of officers injured on duty and the adequacy of their equipment was called into question.

There are currently three types of batons:

1. The Monadnock PR24 side handled baton can be either a rigid one piece baton or extendable from a shorter form for easier transport. Weighing around 600 g

with a shaft of polycarbonate plastic or aluminum, it has a fixed grip at right angles to the shaft towards one end. It is about 60 cm long. The addition of the handle to the shaft makes it very versatile with over 30 blocking and striking techniques available to the officer. Correct usage in stressful and challenging situations requires extensive and ongoing training. In some restraint situations, baton strike from the PR24 type is ineffective at producing the desired effect as not enough energy can be imparted from the strike.

2. The straight friction lock baton (e.g. the Asp) weighs less at 560 g and extends from 13 to 39 cm when racked (extended) with a flick of the wrist. It is carried unobtrusively on the belt and does not impede the general movement of the officer. It is made of hollow gun metal with a small metal knob at the far end. This gives more weight distally, but it is prone to becoming flattened and rough over time as the baton is closed by striking this end against the ground. This change in shape may increase the chance of injury in a forceful strike.
3. The acrylic patrol baton type has a solid or hollow nylon shaft with a ring of rubber separating the shaft and handle. It has fixed lengths of 56, 61 and 66 cm. It is broader than the friction lock type and therefore less likely to cause injury because the imparted energy is spread over a larger area. This is even though its weight is slightly less at 500–580 g. The heavier weights of these types of batons are used in public order disturbances.

In the United States, a 26 in. hickory (wooden) straight baton is used (similar to group 3 above). The situation across the Australian states is very variable with intra-state differences relating to specific police staff; for example, plain clothes staff may use an Asp type whereas uniformed officers are equipped with straight or side-handled batons.

Batons are used in offensive and defensive strikes, blocks or jabs. Strikes are made from an officer's strong (dominant) or weak (non-dominant) side, and clearly the potential for injury varies with the baton mass and velocity at impact, the target area and over how much surface area the force is applied to. Although no body area is absolutely forbidden to strike, an officer must use a proportionate response to the situation he faces knowing the potential to injure. Although target areas are divided into low-, medium- and high-risk areas as below, maintaining a distinction between them could be very difficult as strikes are made in dynamic situations where an initial target area may change as the potential detainee moves.

Target areas with a low injury potential are the areas of the common peroneal, femoral and tibial nerves on the legs and those of the radial and median nerves on the arms. There is a low probability of permanent injury with the main effects being seen as short-lived motor nerve dysfunction, as in a "dead leg", and bruising.

The areas of medium injury potential involve bones and joints including the knees and ankles, wrist, elbow, hands, upper arms and clavicle. In these cases fractures, dislocations and more extensive soft tissue injuries would be expected. Lastly, those areas with the highest risk of injury include the head, neck, throat, spine, kidneys and solar plexus.

The commonest injury to be seen will be bruising, and this is often in the pattern of so-called "tramline bruising" where two parallel lines of bruising are separated by a paler area. This is not unique to a baton injury but reflects an injury caused by any cylindrical hard object. The absence of bruising or other findings does not mean that a baton was not used as, for example, a degree of cushioning can occur from clothing. If the end of a baton is used to jab with, then circular bruises may be seen. It is possible for a detainee to have signs but with minimal symptoms or even be unaware of being struck. However, a move towards the friction lock batons makes this less likely.

An impact over a bony surface may produce a laceration. Abrasions are possible from the surface of a damaged baton. Fractures need to be considered where there are the traditional clinical signs of local pain, swelling and loss of function. X-ray confirmation is needed as soon as possible.

Considering the forces which can be applied when necessary, there is the potential for significant injury with bruising and rupture of internal organs including the heart, liver, spleen or kidneys or a head injury. The HCP should refer suspected cases for hospital review without delay especially if a confirmatory history for events is unavailable. Particular care is needed in those who are intoxicated as they are difficult to assess.

Individually held irritant sprays or gas canisters that are delivered from a hand-held device or from armored vehicles are increasingly popular and are intended to disorientate and to transiently incapacitate an individual. Details of the use and effects of these are covered in Chap. 6.

Conducted electrical weapons (CEW)/TASER® are used by a large number of police forces in North America, UK, Australia and in China. Details of the effects of these are covered in Chap. 8.

Water cannons are often mounted on armored vehicles and are capable of directing a powerful jet of water over long distances and with such force that grown adults are knocked off their feet.

Rubber bullets are hard solid chunks of rubber that are shot from a shot-gun like device. These bullets when used properly can cause painful soft-tissue injuries but have been known to cause fatal injuries when used improperly or when vulnerable parts of the body had been struck.

Lethal force—Here officers aim to prevent a lethal threat to another person or to avoid a lethal threat to himself.

HCPs involved in the examination and evaluation of individuals following an arrest must be aware of the above concept of the “use of force continuum” as such understanding will allow a much more informed ability to form opinions and comments on the sequalae of the use of such force. Ultimately though, it would be for the appropriate courts and tribunals to decide on the appropriateness of an officer’s decision on how much force was used in response to a threat posed or perceived.

Methods of Physical Restraint

Physical restraint of an individual involves actual physical contact. The outcome of such contact is of course a function of the degree of force applied to restrain an individual and the degree of force used to resist such a restraint.

Upper Limb Restraints

A simple tight hand grip of a wrist, forearm or arm of an individual could easily result in bruises over the areas of the hand grip, such bruises may range from small oval bruises suggestive of fingertip bruises to larger patches of bruising. Forceful struggle against such a restraint will of course lead to bigger or more areas of bruising from repeated attempts to grip, etc. In situations where the individual's arm may be forced to the back of the body to facilitate the application of handcuffs, dislocation of the shoulders can occur.

Body Tackles

Body tackles will often result in falls of both the officer attempting to restrain the individual as well as the individual themselves. Injuries will typically include bruises and abrasions over hands, elbows, knees, etc. However, in situations where the fall was on a hard surface or was more complicated, more complex and severe injuries such as fractures may be seen. In many instances with such body tackles, the individual would end up lying on the ground and the arresting officer applying various degrees of force to keep the individual on the ground. Occasionally, deaths have occurred when it was suggested that several officers had jumped on an individual in such a position and such an individual was traumatically asphyxiated by the weight of all these officers acting on him.

Neck Holds

These are perhaps the most controversial form of physical restraint and the most problematic. Proponents of such holds claim that they are safe and effective and attribute their origin from judo, which has used these holds for centuries. Such holds are used in competition regularly with very rare if ever reports of serious injury or fatality. Others argue that such a means of restraint is inherently unsafe and has too narrow a margin for error to be used for restraint of an individual. The frequent use of the judo or mixed martial art (MMA) professional fights as examples of the safety of such holds is artificial since competitors in judo and MMA are highly skilled, trained and physically fit individuals. The fighters are all aware of the limits of the neck holds and are also watched closely by a professional referee. Individuals will frequently "signal defeat" to end the "hold". Such is never the case in a real-life crowd control situation.

Neck holds have been divided by many authors into:

1. Forearm holds—Such a hold involves the use of the forearm placed horizontally across the front of an individual's neck. The person applying the hold is positioned at the back and using the free hand, this forearm is pulled backwards forcing the individual's neck structures particularly the trachea against the

cervical spine, hence constricting it and causing difficulty in breathing. Theoretically, the individual restrained ceases to struggle and resist restraint because of this difficulty in breathing.

2. Sleeper holds—This hold is even more ambitious as it purports to apply pressure on the carotid sinuses, and hence result in transient loss of consciousness. It is applied by placing the entire upper limb around an individual's neck so that the neck is caught or pinched between the arm and forearm. Flexion of the elbow joint applies pressure to both sides of the neck and the individual loses consciousness, and hence is restrained. Proponents of this hold talks about reducing cerebral cortex circulation via bilateral compression of the carotid arteries and jugular veins and that a painless unconscious state is achieved in 7–10 s [12].

Such a division is helpful in appreciating the supposed intended effects of these holds. In practical situations where an individual may be violently struggling, such a clinically accurate application of neck holds will be challenging to perhaps most, apart from the highly skilled and practiced judo exponents. No matter how well and how many individuals in a police force are trained on the use of these holds, it will be unusual that they will be able to maintain such expertise in the course of their career and also to have sufficient and regular opportunities to use such holds so as to be truly experts in their safe use.

The Pathophysiology of Neck Holds

Most forensic literature, even those published in the last decade attributes the effects of neck holds to one or more of the following:

1. The "forearm hold" applies pressure across the front of the neck and hence also on the thyroid cartilages. Indeed, where excessive force has been applied, fracture of the thyroid cartilages may be found.
2. The "forearm hold" will also result in the backward displacement of the tongue, hence occlusion of the hypopharynx.
3. The "sleeper" hold on the other end is believed to result in compression of both carotid arteries, hence decrease the carotid blood flow to the brain. Reay and Holloway [13] are often quoted as having demonstrated that the application of such a neck hold decreases blood flow to the head by 85%.
4. The "sleeper" hold may also be due to stimulation of the carotid sinus, which can produce bradycardia and a transient loss of consciousness. Carotid sinus stimulation is a common enough finding and hence conceptually this alleged mechanism commonly referred to as the "vasovagal effect" was often offered when no definitive findings were present to indicate another mechanism for the cause of death.

More recent reviews by Ross and Chan [14] as well as Di Maio and Di Maio [15] have collected experimental as well as focused serial collections whereby many of the above supposed or accepted mechanisms were challenged. Indeed, readers are encouraged to reflect on the rather provocatively titled article from Glatten and Karch [16]. Indeed, they call for a clearer focus on such cases and have supported the use of the collective term of Excited Delirium Syndrome to study such deaths.

There is no doubt that excessive force applied to the neck in any neck holds that results in injury to the laryngeal cartilages especially the thyroid cartilages can lead to serious neck injuries and possibly death. It is suggested that to kill, the hold would need to be applied for at least 2 or more minutes. In reality, this is quite a long time and seldom supported by independent witnesses to deaths in such incidents.

Vilke in reviewing the work of Reay and Holloway argues that the decreased blood flow was "capillary" in nature and may represent a decrease in blood inflow as well as blood outflow from the brain. The decreased blood outflow from the brain, effectively a result of the increased pressure from the neck hold, increases the venous pressure in the neck.

Raschka et al. [17] performed measurements on nine judokas and were able to demonstrate a reduction in the end-diastolic flow in the mid cerebral artery from a baseline peak flow of 85.3–4.2 cm/s. What was however more relevant was that none of the subjects lost consciousness and even more pertinent was that a pulse oximetry reading from a probe on the ear measured only a decrease from 97.9 to 93.2% only during the hold.

The carotid sinus syndrome can be diagnosed when carotid sinus stimulation produces a systole exceeding 3 s or a fall in systolic pressure exceeding 50 mmHg. However, this syndrome is found usually in older individuals. In two different studies, each involving 25 elderly subjects, Parry et al. [18] and McIntosh et al. [19] were unable to produce the above physiological changes in the majority of the subjects. Indeed McIntosh was able to produce a drop in blood pressure of more than 50 mmHg in only three individuals. Suffice to say that none of the subjects demonstrated any near-death changes.

It is now believed that sudden death in the course of an arrest where neck holds and or restraints are used particularly involving a violent struggling individual are multifactorial with inter-linked causations.

Physical Restraining Devices

Handcuffs

By and large the most commonly used restraining device is that of the metal handcuffs and to a lesser extent waist and ankle chains. Most handcuffs are fitted to both wrists of an individual with their hands behind their back. In some jurisdictions, individuals are handcuffed with their hands in front, which is a much less desirable position for restraint. Guidance on the use of handcuffs by The Association of Chief Police Officers of England, Wales and Northern Ireland [20] makes it clear that the use of handcuffs is an "intentional application of force to the person" and amounts to an assault unless it can be justified. Such justifications can be summarized simplistically as:

1. A person may escape or attempt to escape.
2. A person is likely to use violence.
3. Assuming custody of prisoners from Her Majesty's Prisons.

Up to the early 1990s handcuffs linked both wrists by a short metal chain but apart from restricting arm movements they offered little else in terms of restraint and if only one wrist was attached to them the handcuffs could quickly become a flail like weapon. Rigid handcuffs, were first trialed in 1993 and have since become standard issue in the UK and the USA. Within Australia, there is a mixed usage of chain and fixed link handcuffs.

Although the ratchet mechanism is the same as with the older cuffs, the fixed joint between the cuffs gives several distinct advantages. Holding the fixed joint allows easy application as simple pressure against the wrist enables the single bar to release over the wrist and engage the ratchet. The ratchet can be locked to prevent further tightening but can also only be released with the key, which requires the detainee to cooperate by keeping still. If the cuffs are not locked then progressive tightening can occur. Correctly tightened cuffs should just have enough space for an additional finger between the applied cuff and wrist. The hands are usually cuffed behind the back one above the other, as handcuffing to the front may still give opportunities to resist detention.

Even with only one wrist within the cuffs, control by the officer can be gained by essentially using the free cuff and rigid link as a lever to apply local painful pressure to the restrained wrist. Techniques allow a detainee to be brought to the ground in a controlled manner or the other wrist to be put within the cuffs. A very gentle application, such as may be experienced by the forensic physician in a personal trial, will demonstrate that it is clearly an effective way of gaining control of most individuals. This may not be the case in those who are intoxicated, have mental health issues, or are violent. Cuffs should fit firmly but not tightly at the narrowest part of the wrist just distal to the radial and ulna styloid processes.

Injuries from Handcuffs

Injuries from handcuffs either reflect relative movement between the cuff and wrist or are the result of direct pressure from the cuff to the tissues of the wrist. It is important to remember that injuries may be unilateral especially where there has been resistance to their application.

The commonest injuries to be found are erythema, abrasions and bruising particularly to the radial and ulna borders of the wrist [21]. The erythema is often linear and orientated circumferentially around the wrist following the line of the handcuffs reflecting direct pressure from the edge of the cuffs. Bruising is commonly seen on the radial and ulna borders with tender swelling often associated with abrasions or superficial linear lacerations from the edge of the cuff. Abrasions reflect relative movement between the cuff and skin surface. However, it is not possible to determine whether this movement is from the cuff moving over the wrist or the wrist moving within the cuff, as the effect of either can produce the same skin abrasions. All of these soft tissue injuries will resolve uneventfully over the course of several days and only symptomatic treatment with simple analgesia and possibly a cold compress is required. Although rare, it is possible to have wrist fractures from restraint using hand cuffs. The styloid processes are the most vulnerable but scaphoid fractures have been reported [22]. Tenderness beyond that expected for minor injuries and especially tenderness in the anatomical snuff-box will need an X-ray assessment as soon as possible.

The earliest reports of sensory damage to the nerves of the wrist first appear in the 1920s with sensory disturbance often restricted to a small patch of hyperesthesia and hyperalgesia on the extensor aspect of the hand between the thumb and index finger metacarpals [23]. This area reflects damage to the superficial branch of the radial nerve and subsequent studies confirm that this nerve is most commonly affected by compression between handcuffs and the dorsal radius [24]. However, injuries to the median and ulna nerves can also occur and these may be in isolation or in any combination. The superficial branch of the radial nerve may be spared with others being damaged [25]. Resultant symptoms are reported as lasting up to 3 years in one case; pain may be severe and prolonged, although the most disturbing symptom to patients is paraesthesiae [21].

Nerve conduction studies may be used to distinguish between a compressive mononeuropathy and a radiculopathy. The majority of cases with significant nerve damage either involve detainees who are intoxicated or have a clear history of excessive pressure being applied by the officers [21]. Intoxication may cause problems through a decreased awareness of local pain, marked uncooperativeness or poor memory for the restraining episode when a significant struggle had occurred. It is possible to have nerve damage with no skin breakage reflecting undue pressure. Although some of the quoted studies predate the introduction of rigid handcuffs, because of the similar ratchet mechanism direct pressure problems are still possible.

Sensory nerve damage causes loss of pain, touch and temperature sensation over an area of skin which is smaller than the nerve's sensory supply because of the considerable overlap between the sensory territories of adjacent peripheral nerves. Lesser degrees of damage lead to tingling, pain and numbness in the appropriate sensory distribution. In acute compression of the nerve, symptoms appear more or less abruptly, and relief of this acute compression should lead to resolution in the course of some weeks. Associated motor weakness can be demonstrated by the correct clinical test within the hand. It should be noted that compression of the radial nerve at the wrist does not result in weakness.

Leg Irons and Chains

Leg iron cuffs and chains are not as frequently used as handcuffs but are seen in the transport of arrested persons particularly those felt to be at a high risk of attempted escape. In less developed jurisdictions, such devices are often routinely used even in the custodial cell.

The proper use of cuffs even over a long period of time should not result in any serious injuries to a restrained individual. Still, prudence demands that any person so detained should be regularly monitored to ensure that there is no undue distress from the restraining devices.

Plastic Fasteners

These self-locking devices are made up of tough plastic and are frequently used in situations where it is anticipated that there will be many persons who will have to be restrained, such as during riots or even in combat situations. Again, when used appropriately and only for periods of time requiring them, such devices are generally safe. In situations where individuals may have also been subjected to chemical restraint compounds such as tear gases, pepper sprays, etc. custodial officers should exercise a higher degree of vigilance for individuals who may be in distress and arrange for transfer of such individuals to better physical locations where better restraint devices can be deployed if indeed.

Plastic fasteners are cheap to manufacture and are effective. In contrast to handcuffs however, they can be accidentally or deliberately over-tightened by the applicator and they will get tighter if individuals foolishly attempt to pull at the loose ends. Too tight an application may compromise blood supply or injure nerves caught against a bone. Hence, such restrainers should be used for as short a time as possible and with the awareness that it may cause serious injuries to the constricted limbs. In less civilized societies, these fasteners have been used to secure fingers or thumbs instead of wrists and can lead to serious injury and possible need for subsequent amputation of such thumbs and fingers.

Spit and Bite Guards

A Spit and Bite Guard (SBG) (also known as Spit Hood) is a transparent, breathable mesh hood that is placed over a detainee's head to restrict the transfer of body fluids from the mouth by means of spitting. These are available for police to use where a person detained is spitting at police officers/staff in custody or prior to arrival. SBG are used as a control measure and are a use of force and so their use needs to be proportionate to the circumstances. Officers should receive specific training prior to using a SBG and anyone place in a SBG should be kept under constant supervision [26].

The use of SBG appears to be increasing throughout the UK. A recent study [27] has shown that there is paucity of information available from police services in respect of quantifying the numbers of police officers who have contracted infectious disease as a result of spitting and/or bites, despite the fact that risk of infection and the need for subsequent prophylaxis is a driver of police services adopting the use of spit guard devices. The authors suggest that the use of SBG represents a form of mechanical restraint rather than a means to prevent transmission of infection. Spit-hoods were found to be used on children as young as 10, with at least 47 uses on children in 2017 and 114 incidents in the first 9 months of 2018 [28].

Restraint Positions

The use of restraint in clinical and policing environments is controversial [29–31]. There has been a lack of research evidence in the field due to a number of factors including the difficulties in collecting and comparing valid data in various situations, in different countries. There have been experimental studies in laboratory settings but these are not always transferable to the real physical restraint circumstances.

In July 2013 the Independent Advisory Panel on Deaths in Custody published 'Common principles for safer restraint' [32]. As a general principle the use of any form of restraint should be limited to situations where de-escalation and other non-physical diversion techniques have failed to resolve the situation.

De-escalation is the use of techniques (including verbal and non-verbal communication skills) aimed at defusing anger and averting aggression [33].

The College of Policing Authorised Professional Practice [34] provides advice for officers and staff on the principles of using force in custody and the prone position. This states that 'officers and staff should avoid using the prone restraint position unless it is proportionate to the threat and necessary in the circumstances. Officers should keep the period for which it is used to a minimum.'

Recent research has concluded that the use of the prone position with violent arrestees is a safe restraint method. Ross and Hazlett [35] conducted a prospective study over 12 months in multiple sites with 17 law enforcement agencies in six states of the United States. Arrestees were placed in the prone position for 1–5 min using a range of force, including handcuffs and hobble (hogtie or maximum restraint position) restraints. No deaths were recorded.

Furthermore Hall et al. [36, 37] reported data from 4828 consecutive use of force events over the period 2006–2013 in seven Canadian police agencies in Eastern and Western Canada. Officers prospectively documented the final resting position of the subject prone or non-prone. Over 2000 subjects remained prone with no subject dying in the prone position.

The effects of prone positioning on respiration have been studied. In a small study by Sloane et al. there were no clinically significant differences in the cardiovascular and respiratory measures comparing seated, prone, and prone maximum restraint position following exertion [38]. Particular care should be taken if an individual is physically unwell, injured, pregnant, disabled, or obese [33].

A recent Cochrane review [39] in clinical settings in adults with respiratory failure has found no effect whether an individual is placed in the prone position or supine. With regard to adverse effects on respiration significant reduction is only seen in restraint in obese individuals forced into a seated position leaning forward so their abdominal mass interferes with diaphragmatic breathing [40, 41]. However the time an individual is left in the prone position should be kept to a minimum to achieve control.

A risk assessment should be performed by the custody sergeant once the detainee is in custody. The assessment of risk is continuous. If a risk assessment is not possible on arrival into the custody suite then the custody sergeant should try to complete this assessment at the earliest opportunity and, if necessary ask for medical advice as highlighted in the report on Near Misses in Police Custody in 2008 [42].

As described in earlier passages, it is common in the course of an action to physically restrain an individual, particularly those who struggle and resist arrests, to end up on the ground face down, either having been body tackled, or having a neck hold applied to subdue them so as to facilitate the application of handcuffs to the back of the body. In fact, it is common to see in the movies or on TV police dramas that an individual is ordered to surrender, place their hands over their head and lie flat face down on the ground. In the majority of arrests, this is safe for all concerned if the individual complies with police instructions.

Care should however be taken for individuals who may have a decreased level of consciousness either from the use of alcohol and/or drugs. Even more problematic are individuals who may be excitable because of acute behavioral disturbance (ABD). Cases of suspected acute behavioral disturbance (ABD) should be taken directly to the Emergency Department (ED) of the local hospital as ABD is a time critical emergency. However on the rare occasions that a detainee arrives in police custody guidance [43] has been developed to assist HCPs in the management of this condition. Although de-escalation and attempts to establish the cause of the ABD should be made immediate referral to the emergency department is essential [44] as pre-rapid tranquilization or rapid tranquilization maybe required.

Awareness should also be developed in officers who may be dealing with individuals from other cultures who may be bewildered because they do not understand the language or the procedures of the land. Cases of deaths occurring during arrest will result in intense media and public scrutiny in most civilized societies.

One particularly notorious restraint position is the so called “hog-tie” position. In this position, not only are the individual’s hands tied behind the back, they are further tied to the ankles; such that the individual’s knees are flexed and the torso may be hyper-extended.

Another form of restraint is the so called “hobble prone restraint position”, now also referred to as total appendage restraint position (TARP). Here the ankles are restrained but may or may not be tied to the wrists. When they are tied to the wrists, much more slack is available such that there is less or little flexion of the knees required.

Deaths have been reported around the world involving persons arrested and placed in such positions, although the actual causes of deaths concluded are varied [11, 45]. Forensic pathologists traditionally agree and believe that the respiratory system is compromised as a result of the position of the body, the splinting of the arms restricting the efficiency of respiratory muscles, combined with elements of central nervous depression from alcohol, drugs or occasionally head injuries.

Review of the Patho-Physiological Effects of Restraint Positions

Critical review of the role of the body weight, body position, etc. associated with the hogtie and TARP positions by Neumann [46] challenges the simplistic argument accepted by many forensic pathologists. Neumann describes the results of several experimental studies by Chan et al. [47] Schmidt and Snowden [48] and Parkes [49], where a variety of physiological measurements such as FVC, FEV1, PaO_2, $PaCO_2$, etc. were taken and measured. No scientific basis was found to even support any significant deterioration in the respiratory abilities of the test subjects.

Chan et al. [50] further conducted a study whereby the "hobble" position and inhalation of pepper spray was combined with no significant respiratory deterioration observed. A third study was conducted by Chan et al. [51] whereby 25 and 50 pound weights were placed over the back in between the shoulder blades of individuals who were placed at the maximal prone restraint position. Readings were compared with when these same individuals were sitting. They recorded decreases in the FEV of 5% with the 25 pound weight and 9% with the 50 pound weight and concluded that such changes were clinically irrelevant.

A retrospective study by Stratton et al. [52] should be reflected upon. This study although retrospective gathered data on 216 cases of "excited delirium syndromes" witnessed by emergency medical services personnel. All these individuals had been "hog-tied" with their wrists and ankles bound together behind their back. There were 20 deaths. Two were excluded from the study as one had died from a pulmonary emboli and another had ligature marks and contusions of the neck. Eighteen deaths were attributed to be a result of "excited delirium syndrome". Despite the presence of emergency medical services personnel there were no successful resuscitation of the cardiac arrests that were observed. It was further observed that all cardiopulmonary arrests were preceded by a short period of about 5 min of labored or shallow breathing after the struggle had ceased. At autopsies, 9 of the 18 individuals had markedly enlarged hearts. Cocaine and/or methamphetamine were present in 78% of the cases. It was also observed that 50% of the individuals who died were obese; however, given the population norm of possibly 65% obesity, this finding could not be commented further.

Restraints in Medical Facilities

Restraint in the health setting has been defined as any restrictive intervention involving direct physical contact where the intervener's intention is to prevent, restrict, or subdue movement of the body or part of the body of another person. Prone restraint has been defined as the use of restraint face down or chest down position for any period of time.

Restraints used in medical facilities may be physical, chemical, or mechanical. Physical includes bodily force that controls a person's freedom of movement; chemical indicates that medication is given to restrict a person's movement (not to treat a mental illness or physical condition); and mechanical means a device, e, g, belt or cuff, that controls a person's freedom of movement [53].

The Department of Health published Positive and Proactive Care: reducing the need for restrictive interventions in 2014 [54]. Recommendations included that staff must not deliberately restrain people in a way that impacts on their airway breathing or circulation; restrictive interventions must not include the deliberate application of pain; the least restrictive option must be used to meet the immediate need; seclusion must not be used other than for people detained under the Mental Health Act 1983; people who use services families and carers must be involved in planning, reviewing, and evaluating all aspects of care and support; and individual support plans must be implemented for all people who use services known to be at risk of being exposed to restrictive interventions.

The Royal Australian and New Zealand College of Psychiatrists (RANZCP) has issued a Position Statement in February 2016 covering restraint with the aim of reducing, and where possible eliminating, the use of seclusion and restraint in a way that supports good clinical practice and provides safe and improved care for consumers [55].

Training in de-escalation is now an essential part of conflict resolution and physical intervention training programs (breakaway training). It is essential that in a clinical setting a multidisciplinary team approach is taken with those involved having the requisite expertise and skills in the use of rapid tranquillization and therapeutic restraint, if required [56].

In 2018 the British Association of Psychopharmacology and the National Association of Psychiatric Intensive Care and Low Secure Units developed a joint evidence-based consensus guideline for the clinical management of acute disturbance [56].

Healthcare professionals need to be aware of the key interventions that may be required: de-escalation, pharmacological interventions pre-rapid tranquillization, and rapid tranquillization (intramuscular and intravenous). In the environment of police custody treatment should be should be restricted to oral therapy (pre-tranquilization) [33]. Pre-rapid tranquillization (pre-RT) has the aim of offering oral medication to agitated patients pre-emptively to address acute disturbance and to avoid escalation and the need for parenteral medication and physical restraint.

Physical Examination

It goes without saying that once a person is restrained and the situation is brought under control, the continual use of the restraint must be evaluated regularly as to its appropriateness. It is not unexpected that individuals who have been restrained may lodge of a complaint or mount a legal challenge to their restraint and detention.

When a HCP is asked to examine such an individual, informed consent for the examination, photography, and release of the report should be obtained. Allegations of assaults should be recorded verbatim if possible and a full and thorough physical examination performed. All injuries should be properly described, located and measured. Color photography with scales and a color palette should be taken and kept with the records.

Bruises and abrasions will be commonly found. Abrasions over bony prominences may have resulted from falls and tumbles. Abrasions or bruised abrasions over the bony prominences of the wrists may be a result of handcuffs. Occasionally, tram line bruises are found and these may be due to blows from batons. Oval (fingertip) bruises may also be found over areas of the upper limbs where an individual may have been held.

Lacerations are unusual unless there had been blows by batons over underlying bones or impacts against hard objects in falls, etc. Incised wounds too will be unusual, unless sharp weapons have been used and there had been a tussle for control of such a weapon. Another not uncommon cause of incised wounds may be from broken glass at the place of incident or arrest. Fractures are rare but may occur from baton blows, falls and occasionally forceful twisting of an arm. Dislocation of shoulder joints too may occur.

It should be remembered that where chemical agents and/or other means of force have been used, specific injuries that may be associated with the use of these devices or agents should also be looked for, their presence or absence documented clearly. Ancillary investigations such as X-rays, CT scanning, toxicology, etc. should be done guided by the history of the incident available to the doctor.

Restraint at a Distance

One of the major problems facing police officers is how to restrain a violent or potentially violent individual, perhaps carrying an offensive weapon, using the minimum appropriate force. Clearly, the tactical firearms units are often required in these situations but there is an increasing trend to look for other "non-lethal" options, which will incapacitate with a lower risk of serious injury. Within the UK, the investigation of firearm incidents is undertaken by the Independent Office of Police Conduct who make recommendations as appropriate [57]. Different countries use different restraint equipment such as water cannon or the firing of different projectiles (e.g. bean bags) and these are subject to consideration for police use at certain times.

Attenuating Energy Projectiles (AEP)

Attenuating energy projectiles (AEP) are used in the UK by specially trained officers. Currently the device approved is the AEP L60A2 and this is fired from a 37 mm breech loaded weapon with the approved launcher the Heckler and Koch L104A2, equipped with an approved L18A2 optical sight [58]. There is a void in the nose of the projectile so reducing the energy. The collapse of the void extends the duration of the impact forces and so reduces the peak force on a surface, such as the skull [59].

The AEP thereby delivers a high amount of energy to maximise its effectiveness, while reducing the potential for life-threatening injury. Reducing the rate of onset of the impact force and reducing the magnitude of the peak force, have both been shown to reduce the severity of injuries in human impact.

This AEP has replaced the L21A1 baton rounds previously used. Baton rounds, previously known as plastic bullets, were first introduced in Northern Ireland in 1970 where there were a number of fatalities. AEP is an alternative to using firearms against those who may use firearms or where there is a major risk to life.

The aim is to hit the individual directly. Injuries are mainly bruises and abrasions, with fewer lacerations, depending on how and where the body is hit. More serious injuries are possible with occasional fractures and bruising to internal organs. Although intra-abdominal injury is unusual, impacts to the chest can give rib fractures and pulmonary bruising.

A similar system is used in the United States based on the ARWEN (Anti-Riot Weapon Enfield) system, the Sage SL-6, and this is the preferred less lethal option of restraint. This has a projectile with a tail and is smaller and faster than the baton round. The pattern of injuries will be similar but if the projectile becomes unstable in flight so that the surface area striking the target is smaller (because of altered orientation), then the potential for injury is increased.

Anyone who has been struck by an AEP should have a medical assessment as soon as practicable (by an appropriately trained forensic physician).

Bean Bag Rounds

Available widely in the United States, some Australian states, but not the UK, these consist of rectangular, square or circular synthetic cloth bags filled with lead pellets and fired from a shotgun. As an example, the “Flexible Baton” fires a bag containing 40 g of number 9 lead shot with a projectile velocity of around 90 m/s. At impact, projectiles are designed to have separated from the shotgun shell and wadding, opened out to strike the target with its largest surface area before collapsing as they lose energy. The effect is to provide sufficient blunt force from an ideal range of 10–30 m to stop an adult’s progress.

In one study, De Brito et al. [60] reported that the commonest injuries were bruising and abrasions followed by lacerations without having retention of the actual bean bag. However, there are significant other serious injuries documented including closed fractures, penetrating wounds with retention of the bean bag projectile (and at times parts of the shell and/or wadding) and internal organ damage. Serious penetrating injuries involved the thorax, eye, abdomen and limbs. Thoracic penetration resulted in one fatality from a massive hemothorax. Blunt injuries included splenic rupture, pneumothorax, compartment syndrome, testicular rupture, subcapsular liver hematoma and cardiac contusions. It was noted that retention of the bag was not always suspected from an initial clinical examination, being detected on subsequent scans. The distance between gun and target was not formally examined in this study.

Clearly, this device has potential for significant trauma to anywhere on the body. Just as with other non-lethal alternatives for restraint, the forensic physician should always consider why such techniques were needed to be deployed; use of drugs or alcohol and psychiatric illness are all common concurrent problems in these situations.

Evaluations and Opinions

HCPs should wherever possible obtain as much information of an alleged incident as possible. If working as an expert, statements of the parties involved, and independent witnesses, photos and videos from surveillance cameras, may be available. It is of course important to establish the credibility of these materials first before considering them.

Findings should be based on what is known. The HCP must be impartial, it is not the clinical person's role to decide the appropriateness of a decision to use force or the degree of force, that is for the legal and public tribunal.

Summary

There exists an accepted but regulated need for law enforcement personnel to use force. Such use of force can and will cause injuries and sometimes death. Such incidents should of course be investigated in an open and transparent manner ensuring that all interested parties are properly represented. The impartiality of such investigative tribunals is the best safeguard to all members of society but must be built on trust [61].

Experts involved in such inquiries must be impartial and should keep up with the rapidly evolving literature. The exact or conclusive pathophysiology of such deaths have yet to be agreed and may never be agreed, for each case is likely to be the cumulative effects of many things, some known and some unknown. Full autopsies must always be performed and toxicological analysis and interpretation sought. Full histopathological studies should be performed and where available newer molecular biological screenings for genetic markers of the heart, brain, etc. New theories based on physiological responses to stress may 1 day help us understand more the triggers for such deaths.

Key Points

- As a general principle during restraint, any force used must be proportionate to the threat faced, be lawful, and necessary in the particular circumstances. Restraint may be physical, chemical, or mechanical.
- Police may use a variety of less-lethal weapon methods, most commonly handcuffs.
- Healthcare professionals working in the custody environment should record clearly complaints of assault made by detainees, with detailed documentation of any injuries found.

Self-Assessment Exercises

1. Describe the injuries that may result from the application of rigid handcuffs and a blow with a baton
2. Define restraint. What are the potential consequences of restraining a violent individual in the prone position? What advice could you give to police prior to an intervention?

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TASER Conducted Electrical Weapons

8

Rich Childers, Ted Chan, and Gary Vilke

Introduction

John H. “Jack” Cover was the original inventor of TASER Conducted Energy Weapon (CEW) technology. Cover was the Chief Scientist at North American Aerospace when it was the prime contractor for the National Aeronautics and Space Administration’s (NASA’s) Apollo Moon Landing program. Cover was a dedicated physicist who in the 1960s read President Lyndon Johnson’s Crime Commission report that urged the development of non-lethal weapons to combat airplane hijacking, riots, and civil unrest. Cover’s quest to develop his first CEW began in 1966 when he developed working models and named them after his favorite childhood character: Tom A. Swift and his Electric Rifle (TASER). CEWs are now used by over 15,000 Law Enforcement agencies worldwide that possess over 500,000 units. As of January 19, 2019, the primary manufacturer of CEWs reports 3.9 million field uses, and 2.5 million training uses for a total of 6.5 million uses [1]. These numbers do not include the large numbers of times a CEW was used to resolve a violent encounter simply by its brandishing or by “painting” the suspect with the laser pointer sight.

Conducted electrical weapon, conducted energy device, electrical weapon, and stun-gun are some of the common terms for any device that delivers an electrical current to incapacitate a victim by disrupting voluntary control of muscles. TASER is a brand of electroshock weapon sold by the company Axon. Though there are other CEW companies, the term TASER is basically synonymous with electroshock weapons due to its widespread popularity.

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Background

Operational Principles

The CEW delivers its electrical energy to the subject either in the probe mode or drive-stun mode. In probe deployment mode, CEWs use compressed nitrogen to fire probes at distances up to 7.7 m (25 ft) (see Fig. 8.1). TASER cartridge models are available to reach out to 11 m (35 ft) as well. These probes, which are designed to pierce or become lodged in most light clothing, are discharged from the cartridge at a velocity of approximately 60 mps (meters per second) (200 ft per second) and can penetrate the body to a depth of no more than 13 mm. Figure 8.2 demonstrates that the TASER X26 deploys the probes at an 8 degree angle, thus the further from the target, the wider the probe spread and the increased likelihood of neuromuscular incapacitation (NMI), while the X2 deploys at a 7 degree angle.

In TASER CEW devices, the live probe cartridge can be removed, or with a discharged cartridge in place, and the CEW used in a "drive-stun" mode by pushing the

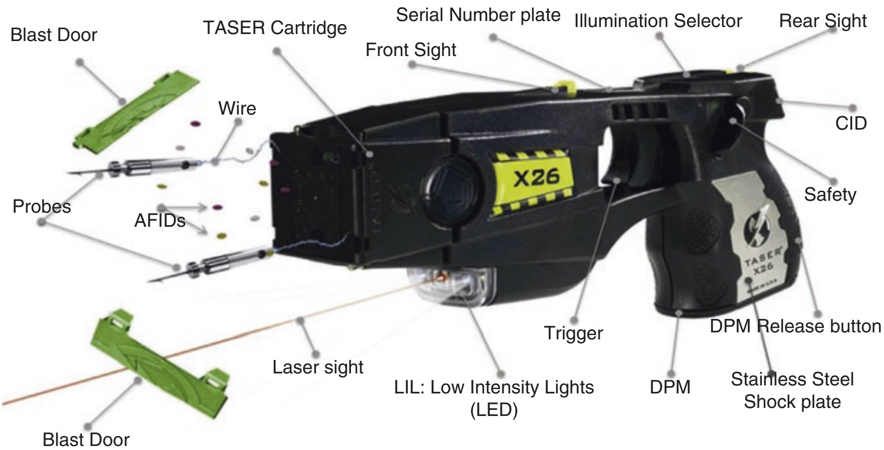


Fig. 8.1 The parts of the TASER X26 during probe deployment

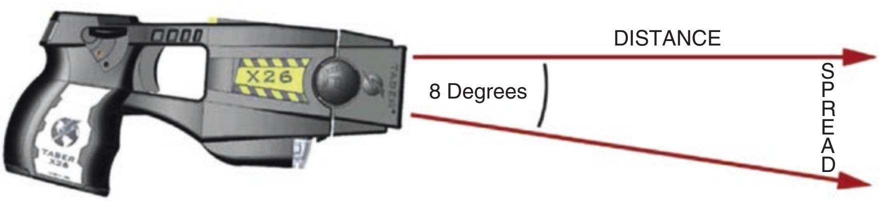


Fig. 8.2 The lower probe of the TASER is launched at an angle of 8° below the laser line

front of the CEW into the skin to function as a higher charge stun gun. Since there is insufficient electrode spread (4 cm) to capture muscles, the drive-stun mode primarily serves only as a pain compliance technique. The X2 CEW can deliver a drive stun without live cartridge removal. Figure 8.3 demonstrates the electrodes of an X26 CEW.

Electrical Energy

There is a great deal of unwarranted concern of electrocution based on lay misunderstanding of the reported 50,000 volts (V) peak open arcing voltage used by TASER handheld CEWs. TASER handheld CEWs deliver only a fraction of the 50,000 V when deployed and activated. In the case of the TASER X26™ CEW, the mean delivered pulse voltage is 580 V with a typical peak voltage of 1900 V (volts) being delivered to the body [2]. Voltage is the difference in electric potential between two points. The average pulse voltage—which is what leads to stimulation—is actually about 600 V. The CEW also generates an open-circuit (arcing) voltage of up to 50,000 V to arc through air or across thick clothing but that voltage is never seen in, or “delivered” to the body. However, it is not the voltage, but the delivered electrical charge, that actually creates a risk for cardiac effects. For example, the static electricity from walking across a carpet

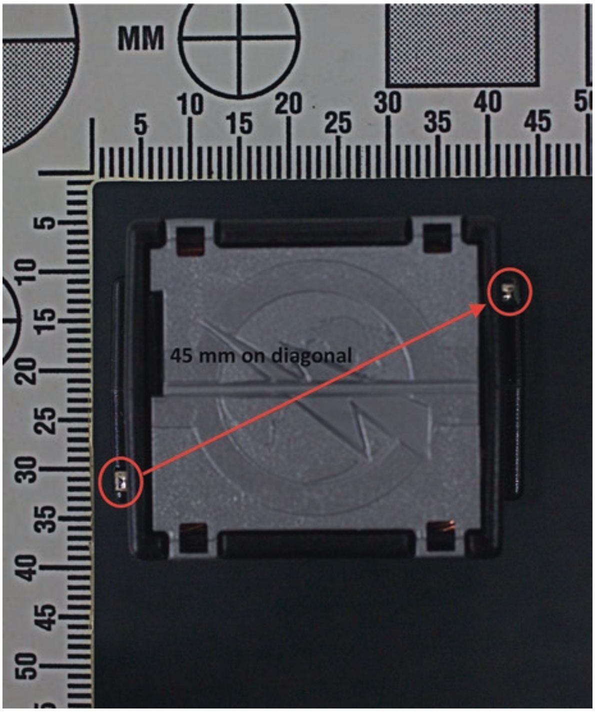


Fig. 8.3 The fixed electrodes of the X26 CEW with a distance of 45 mm when used in drive stun

can generate 30,000–100,000 V. Van De Graaff generators can have over a million volts that can be safely touched by humans.

The popular TASER X26E was released in 2003 and delivers a charge of 110 microcoulombs. Two newer releases, the X2 (2011) and X26P (2013), both deliver a charge of 63 ± 9 microcoulombs. All have a pulse rate of 19 pulses per second [3]. The X26 CEW main phase charge, which determines capture, ranges from 50–100 μC depending on the connection quality. The X26 CEW average net current is approximately 1.9 mA (milliamperes) (=19 pulses per second • 100 μC) and the peak current is only about 3 A. By way of comparison, a TASER M26™ CEW has a peak current of about 17 A; an International Electrotechnical Commission (IEC) Level IV static electricity shock has a peak current of 30 A; traditional non-LED Christmas tree light strings have on average current of 0.4 A or 400 mA, which is about 200 times the average (or actual or aggregate) delivered current of the TASER X26 CEW. Figure 8.4 is a recording of an X26 CEW probe deployment in a human volunteer [4]. What determines the capture is the electrical charge which is the area under the curve [5–7].

CEWs deliver a rapid series of very short duration (10–100 μs) electrical pulses to efficiently capture alpha-motor neurons while having minimal cardiac effects. Each pulse has less peak current than a strong static electricity shock that

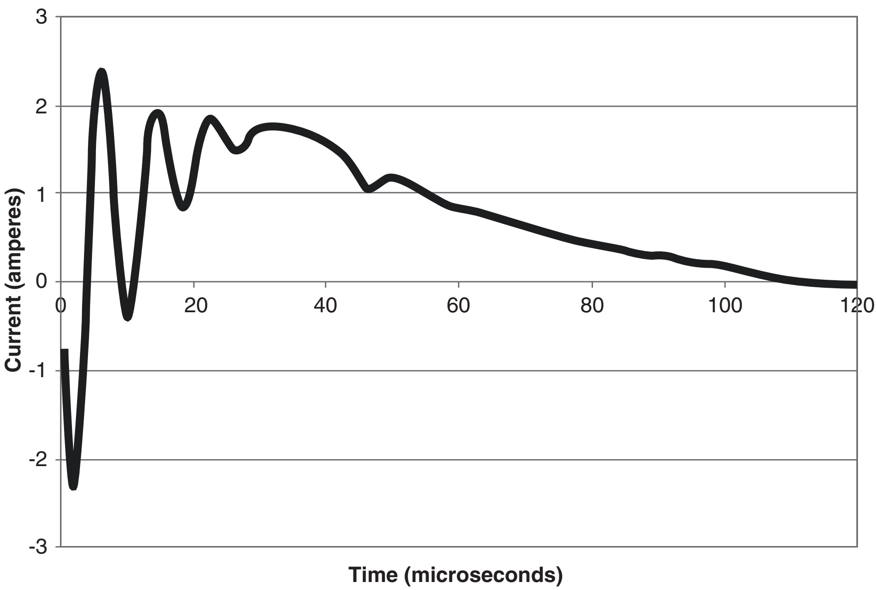


Fig. 8.4 Output waveform of X26 CEW pulse. Taken from a human probe application [64]. The initial short negative and positive peaks are the "arc" phase. They do not contribute to stimulation due to their mutual charge cancellation. The current delivered between 10 and 110 μs contributes to motor-neuron stimulation

one could get from a doorknob on a winter day. Just as a strong static shock temporarily incapacitates someone, this series of 19 very short duration shocks per second delivered in probe-mode from the X26 CEW will likely temporarily incapacitate a person.

The stored energy in the TASER X26 CEW is about 0.36 joules (J) per pulse (J/pulse), and the delivered energy is about 0.1 J/pulse. By comparison, an automatic external cardiac defibrillator (AED) delivers up to 360 J, over 3000 times greater than the X26 ECD. Or, if one thinks about it, this limited amount of delivered electrical energy able to be transferred to a person makes sense as the TASER X26 CEW is only powered by a battery of two 3 V cells (Duracell® CR123s), commonly used in some small digital cameras.

Selective Stimulation

In probe mode, the stimulus train of narrow pulses is intended primarily to capture the motor neurons and cause the nerve-mediated activation of skeletal muscle contraction. This serves to disable the individual through NMI and their ability to voluntarily move. In addition, it also elicits strong sensory overload and discomfort. An important safety concern of the electrical weapon technology is to significantly minimize or eliminate stimulation of the heart, which could cause life-threatening dysrhythmias or cardiac arrest.

The minimum level of charge needed for stimulation is much higher for cardiac cells then myelinated motor nerves [8]. In addition, the heart is also located deeper within the torso. With probe barbs embedded just at or below the skin, much more energy is delivered to the skeletal muscle than cardiac tissue. Thus, relatively little, if any, current will pass through the heart. This effect of relatively low penetration of the electrical charge into the heart given surface or near-surface stimulation of tissues is well known and well-studied both in the electrical safety literature as well as the medical literature of transthoracic pacing and defibrillation.

From an efficacy perspective in terms of efficiently activating skeletal muscle between and near the probes, the CEW stimulus pulses appear to selectively stimulate muscle controlling motor neurons more than the heart. Similar selectivity is seen from a safety perspective in terms of nerve-mediated activation of skeletal muscle with a wide safety margin in comparison to corresponding current levels that would be needed to excite or fibrillate the heart.

Drive-Stun

In the drive-stun mode, the electrical energy is delivered over a very short pathway between the electrodes of the CEW. The result is isolated pain, but not enough electrical charge or electrode spread to cause motor neuron activation and skeletal muscle capture. While similar, the TASER CEW should not be confused with generic "stun guns." Generic stun guns deliver less average current (typical values of 0.3–0.5 mA) and deliver it over a short pathway between two fixed electrodes. With stun gun electrodes only 2–5 cm apart—and the lack of skin penetration—the current flow is primarily across the epidermis and then along the dermis between the electrodes and there is no significant penetration beyond the fat layer. Thus, there is insufficient current in the skeletal muscle layer to capture motor neurons and achieve muscle control.

Epidemiology

CEWs have now been applied to over five million human beings with over three million field uses and over two million uses in training. The existing literature shows that the introduction of CEWs decrease serious adverse outcomes compared to other lethal force methods, and that death or serious injuries are extremely rare. There have been no deaths following CEWs use in training scenarios. There are several papers describing the epidemiology of suspect injuries and a few comparing the suspect and officer injury rates with alternative control modalities. Eastman et al. did a prospective study of 426 CEW uses in Dallas Texas [9]. He reported no subject injuries beyond scrapes and cuts requiring only first aid. Notably he found that in 5.4% of the CEW uses, lethal force was replaced by CEW use. Bozeman et al. prospectively studied 1201 uses in five law enforcement agencies in the USA [10]. There were two serious injuries from falls at a rate of 0.17%. One was a 6.5-mm temporoparietal intraparenchymal contusion and the other an 8-mm cerebellar epidural hematoma. Both subjects were admitted to the hospital for observation and discharged after 2 and 3 days, respectively, without neurosurgical intervention or long-term sequelae. There was a case of rhabdomyolysis which was discussed in detail in the paper and was clearly unrelated directly to the CEW usage.

In the Bozeman study, there were two deaths: Both cases were men in their 30s who struggled violently with police both before and after CEW use and on whom other physical force was used to take them into custody. One subject had a high body mass index and was involved in a foot pursuit and prolonged physical struggle with police, during which two conducted electrical weapon discharges were used. He collapsed approximately 20 min later. At autopsy, he was found to have a dilated cardiomyopathy and cocaine was present in his blood. The second subject was agitated and violent, with a history of mental illness. After an extensive struggle, during which pepper spray and two CEW discharges were used, he was restrained in a prone position. He collapsed an estimated 5 min after CEW use. An autopsy revealed no anatomic cause of death, but olanzapine at 170 ng/mL was present in his blood. CEW use was not determined to be causal or contributory to death by the medical examiner in either case.

Strote et al. studied 1101 consecutive uses by the Seattle Police Department, Washington, USA [11]. He found eight "restraint related" trauma injuries. However, he did not distinguish the injuries typical of CEW usage (e.g. head injury from fall) from those typical of other control techniques (broken limbs, dislocations, etc.).

Thus, the Strote study is less helpful for estimating CEW rates except to place an extreme upper bound at 0.73% which is far higher than the combined rate of 0.12% from the Eastman and Bozeman studies. The UK Home Office publishes statistics on CEW usage quarterly [12]. As of December, 2016 they had 14,126 actual field CEW applications of current to suspects, not including displays and arcing. Unfortunately, the injury rate has not been publicly reported.

Smith et al. did a cross-over analysis of CEW usage in Richland County (South Carolina, USA) and the Miami Dade (Florida, USA) police department. They found that the Miami data showed an 87% reduction in suspect injuries and a 68% reduction in officer injuries. Results for smaller Richland County did not reach statistical significance [13]. Brewer et al. performed a weighted meta-analysis of reductions in suspect and officer injuries in the first full year of a law enforcement agency adopting the CEW. They found that the suspect injury rate was reduced by 64 ± 12% while the officer injury rate was reduced by 63 ± 8% [14]. The U.S. DOJ (Department of Justice) research arm NIJ (National Institute of Justice) sponsored a combination cross-over and a case-control study of the impact of CEW adoption by MacDonald et al. [15]. They studied twelve agencies and found subject injury reduction of 65% but no officer injury reduction. Their data suggested a 56% reduction in the ARD (arrest-related death) rate but this did not achieve statistical significance due to the small number of deaths.

O'Brien described the prevalence of mental illness in 141 TASER exposures during a 2006–2007 trial of CEW use in New Zealand. They found 21% of the subjects were having a mental health emergency. Compared to a criminal arrest, TASERS were twice as likely to be discharged as in mental health emergencies. No deaths were reported [16].

Bailey also examined the prevalence of substance abuse and mental illness in 233 cases of TASER exposure that occurred between 2008–2009 in Louisville, KY and recorded by LEOs. Of the 233 total cases, drug use was confirmed in 35%. Twenty-six percent were using alcohol, 4.6% stimulants, 4% multiple substances, and 4% other substances. Sixteen percent had mental illness. One death, not described in detail, occurred in a patient taking stimulants who subsequently died en route to the hospital after two TASER shocks [17].

Gardner reviewed a law-enforcement database of TASER use to determine the prevalence of pediatric subjects in 2026 consecutive TASER uses. Five percent of these TASER uses involved pediatric patients. Ages ranged from 13 to 17 years with a mean age of 16.1 years. There were no significant injuries reported. Twenty subjects were noted to sustain 34 mild injuries; these included the expected superficial punctures from the CEW probes as well as superficial abrasions and contusions. No deaths were reported [18].

Finally, Lee et al. asserted that the ARD rate actually went *up* in the first year after CEW deployment and then returned to normal [19]. This paper failed to give actual numerators and denominators, disclosing only percentages, and the authors have reportedly declined to share any of their data with other researchers. The speculated mechanism for this curious finding was that overly aggressive use of the CEWs in the first year escalated the violence in arrest situations and led to more officer-involved fatal firearms shootings. That speculated mechanism is inconsistent with all other research in this area.

Morbidity and Mortality

Probe Marks

The probe impact leaves a very distinctive disc-shaped mark of ~3 mm diameter. Figure 8.5 depicts this post-mortem. Obviously in a living person, wound evolution with inflammation and healing processes would occur. Figure 8.6 demonstrates wound healing at 24, 48, and 96 h post exposure in a living subject. Complete healing and recovery of normal skin appearance may take up to a month. In addition to the initial wound is a small puncture wound from the shaft of the probe itself may be visible as shown in Fig. 8.7. The above will be seen where the probe actually penetrated the skin and the thicker collar impacts the skin. In about 20% of cases, one of the probe connections is made by arcing through thick or baggy clothing. In that case there will be no characteristic disc mark but rather a slight burn from the arcing current. This response may be more obvious in darker skinned individuals.

Ocular Injury

The head, face, and neck receive 1.4% of probe deployments [10]. The sharp probe clearly carries a risk of injury to the eye should direct contact occur. In a systematic

Fig. 8.5 Post-mortem CEW probe wound. Other wounds were from violent prolonged struggle

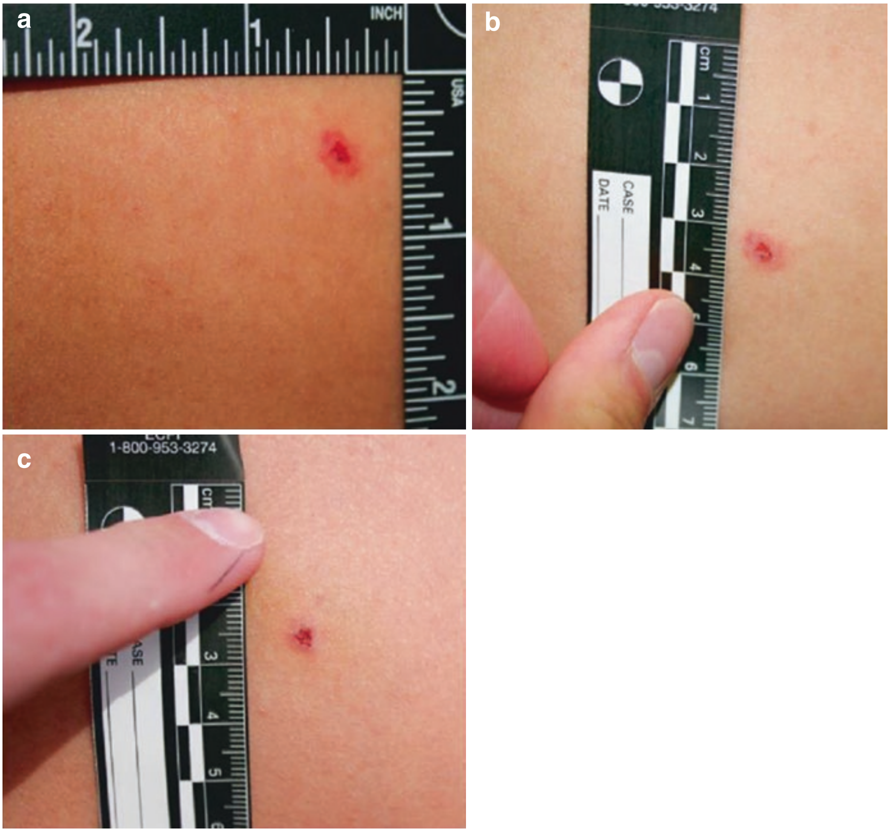


Fig. 8.6 CEW Probe wounds. Parts (**a**), (**b**), and (**c**) are respectively 24, 48, and 96 h post exposure

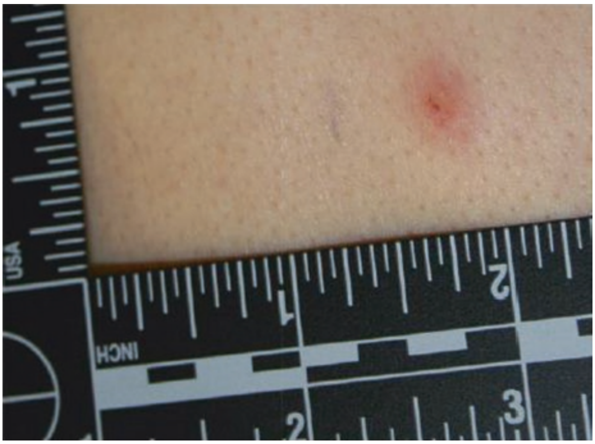


Fig. 8.7 CEW Probe wound 24 h post exposure in which the small dart puncture wound is noticeable

review of literature and open source media, Kroll found a total of 28 ocular injuries from a TASER probe. Using the total number of TASER field uses has a denominator, a risk of 1:123,000 was calculated. Eighteen of these injuries led to a complete loss of vision. There were seven cases of partial blindness, and two cases of normal vision after surgical repair. One case was lost to follow-up after attempted surgical repair [20].

There has been a case report of a TASER exposure causing a cataract [21]. High energy powerline injuries can cause remote electrical damage to the eye [22]. However, it is unlikely for TASERs to cause remote injury to eye tissue as the electrical output appears too low to cause such damage. Supporting this are a number of case reports with peri-ocular probe penetration without any reduction in vision or reported development of cataracts [23].

Skull Penetration

The penetrating part of the probe is either 9 or 13 mm long, which is sufficient to penetrate the skull if it strikes at a perpendicular angle. See Fig. 8.8 for an image of a TASER probe. There have been four published case reports involving skull penetration [24–27]. There were no infectious or neurological sequelae. In one case the broken-off probe tip was left in the outer cortex [24]. In the other three cases, the probe penetrated the skull and a neurosurgical procedure was required to remove the probe [25–27]. None of the patients had neurologic complications observed prior to discharge.

In another case an officer chasing a suspect was accidentally shot in the back of the head by his partner [28]. He quickly fell to the ground and had a loss of consciousness, clonic-tonic seizure activity, and post-ictal confusion. It is difficult to determine whether the seizure activity was caused by the possible electrical stimulation or from brain trauma that occurred as a result of the fall. This is the only case-report published that associates CEW use with seizures.

Fig. 8.8 CEW probe, the active portion of the dart comes in a 9 mm and 13 mm length

Pneumothorax

A pneumothorax was reported in a case involving a 16 year old suspect who received a probe into his left chest while attacking an officer [29]. He was 180 cm tall, weighed 66 kg giving him a BMI (body mass index) of 20.4 kg/m [2]. The probe was removed in the hospital; he was treated for the pneumothorax, and was discharged in 2 days. However, it was not clear to the authors that there was a direct barb penetration into the thoracic cavity to explain the pneumothorax. It's possible that the finding was a secondary pneumothorax caused by a strong valsalva leading to high intrathoracic pressures.

Vertebral Fracture

Cases of vertebral compression fracture have not been reported in field use on suspects. However there have been published case reports of compression fractures in LEOs in training exposures across the back [30, 31]. In one case the officer had pre-existing osteoporosis and the other case a LEO had pre-existing osteopenia. These case reports, out of over two million training exposures, suggest an injury rate that compares favorably to jumping sports such as basketball. Additionally, it is believed that the compression fractures are caused by the person coming violently forward after the completion of the CEW exposure. This is suspected because the compression fractures were anterior, not posterior fractures. When a subject receives a back exposure to the CEW he arches backward, not forward. Thus, if the CEW discharge was the direct cause of the fracture, the fracture should be posterior and not anterior. No posterior fractures have been reported.

Fall Injuries

The design objective of the CEW is to cause a violent person to lose control of major muscles from NMI in order to stop the resistance or dangerous behavior. A standing suspect can suffer a sudden and uncontrolled fall with all of its obvious risks. The typical fall-related injuries, varying with ground surfaces, are to be expected. These include lacerations, bruising, hematomas, dental damage and limb and skull fractures. Bozeman et al. reported two significant head traumas from CEW-induced falls; Mangus et al. reported on three such injuries [10, 24].

It can be difficult to separate the cause of a fall between the CEW, intoxication induced imbalance, physical resistance, and other LEO interactions. There have been approximately twelve cases of fatal falls where the CEW probably played a role. With sufficient probe spread, NMI can be significant and an uncontrolled fall is possible [32]. Thus, traumatic injuries, including fatal traumatic brain injuries, are possible. Investigators have previously completed a database review of arrest related deaths in individuals who suffered TBI after CEW induced fall. Out of three million field uses, they found 16 probable cases of fatal brain injuries [33].

Illustrative Case The mother of an emotionally disturbed individual asked someone to call 911 after her son did not answer the door of his New York City apartment. When police arrived, the son ran onto the fire escape outside his third-floor apartment.

Fleeing the officers up the fire escape, he tried to enter another apartment on the fourth floor by pushing in an air-conditioner. When unsuccessful, he then descended to the second-floor fire escape and from there jumped down to the security-gate housing for a ground-floor storefront, which was about 10 ft from the sidewalk.

As an officer was securing himself on the second-floor fire escape, the subject jabbed at the officer with an 8-foot-long fluorescent light tube.

Under orders from a lieutenant, the officer on the sidewalk, used the CEW on the subject, who had NMI and subsequently fell to the sidewalk, striking his head. The police said an officer at the scene had radioed for an inflatable bag, and it was not clear why the bag had not arrived when the subject fell, or why the officers had not waited for it before using the TASER on him.

The subject was taken to a hospital with serious head trauma and was later pronounced dead [34].

Drive-Stun Burn Marks

As mentioned earlier, the CEW may also be used in the "drive-stun" mode without the deployment of probes. The effect of this mode is cause localized pain to encourage compliance. The characteristic sign is a pair of burn-marks about 4 cm apart corresponding to the 4 cm electrode spacing on the muzzle of the weapon, or the exposed electrodes on a previously discharged cartridge. An example of such a pair of marks is given in Fig. 8.9.

Drive-stun applications may cause more skin trauma than the probe-mode applications. The fully penetrated probe forms a low resistance path and hence there is minimal heating at the skin. The drive-stun application, on the other hand, forms a short, high electrical resistance on the epidermis, which can lead to some localized burns. An example is shown in Fig. 8.10. Additionally, the act of pressing the CEW into the subject with enough force to improve electrical contact along with the subject's movements increases the possibility of trauma to the skin. With such movement, a single 5-s CEW cycle can result in numerous skin contacts and resulting damage.

Burns from Ignition of Flammable Substances

Under certain circumstances with a volatile substance, as well as suboptimal application of the CEW in probe mode, can cause risk ignition and subsequent injuries. With good probe-to-body connections there is no significant arcing and hence no

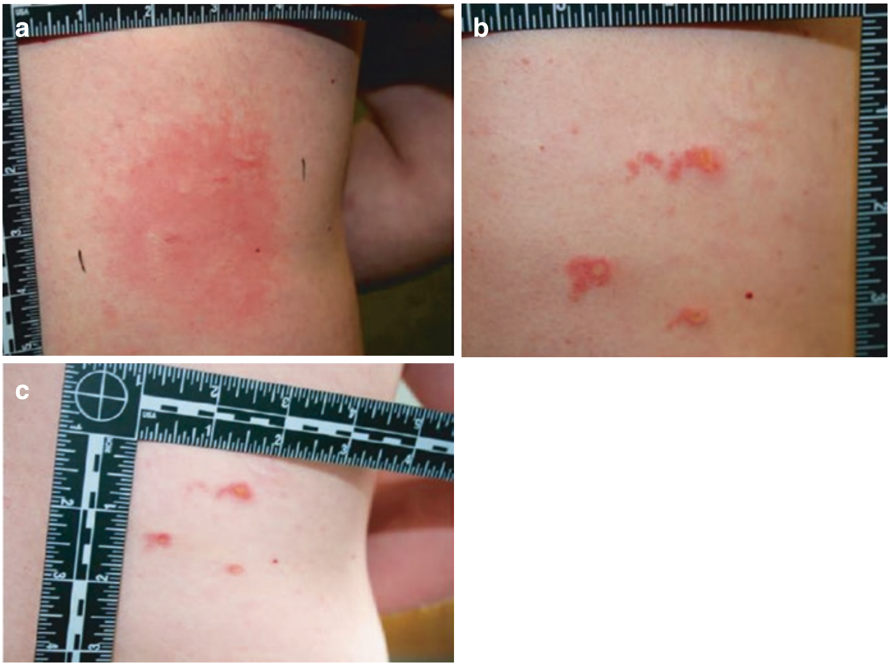
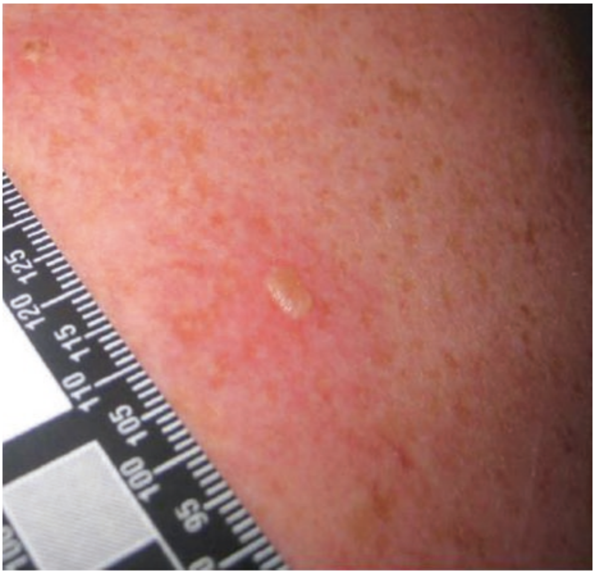


Fig. 8.9 Drive-stun marks. Parts (**a**), (**b**), and (**c**) are respectively 0, 24, and 72 h post exposure

Fig. 8.10 Example of drive-stun blistering



real opportunity for ignition of a volatile substance. (With older probes there was also some arcing within the "eye of the needle" where the wire connects to the probe which could theoretically ignite an ideal gas-air mixture.) However, if one probe fails to make a good connection then the 50,000 V open circuit "arcing" voltage will attempt to complete the connection. If the disconnected probe is more than 6 cm from the body, then an arc is unlikely to occur at the subject. In that situation, the arc will occur back at the muzzle of the officer's CEW. If this occurs, there is still little risk of ignition unless the volatile substance has sufficient concentration near the officer.

The volatile substances of most concern are: OC (oleoresin capsicum) spray, petrol, and cooking gas. The OC spray is only of concern if it is alcohol-based or contains other flammable substances or carriers. OC spray is available with non-flammable carriers and these are preferred within agencies that use electrical weapons. However, caution is necessary because some OC sprays clearly labeled nonflammable have been shown to be flammable during testing. Petrol itself is not ignitable with a spark. Evaporated petrol combined with air is highly ignitable and that is the key ingredient of the modern automobile engine.

In a database review of arrest related deaths designed to quantify the risk of burn injury from CEW use, six cases of fatal burn injury and four cases of major non-fatal burns were confirmed. At the time of the review, there had been an estimated 3.17 million field uses of the TASER. Like many of the risks of CEW use, the risk of burn is very small [35].

Illustrative Case A man who doused himself with petrol then caught on fire after police fired a TASER at him died from his injuries. The 47 year old was hospitalized and later died. Police said they used pepper spray while trying to take the subject into custody, but that he was never handcuffed. The subject had a can of petrol and a small lighter in his hand at one point. He tossed petrol at officers, but no one was injured. The Texas Rangers were investigating whether a lighter found at the scene could have contributed to the fire and whether the CEW played a role. Two of subject's sons who live nearby said their father had been threatening for months to burn himself and his house. His wife was seeking a divorce and he didn't want to have to leave the house, the sons said the subject also had a history of mental illness [36].

Probe Infection

A recent study examined the infection risk associated with CEW use [37]. The authors estimate that approximately 3.3 million darts have penetrated human skin, however there have been no reported infections. The authors confirmed this by completing a literature review and also surveying 208 trainees who had a CEW exposure. Data indicates that approximately 5% of probes had Staphylococcus aureus on them. The authors propose this low infection rate is secondary to a clean manufacturing process as well as the electrical pulses sterilizing the dart through a process called electroporation. Electroporation occurs when electrical pulses cause damage to ion channels or cell walls.

Metabolic Derangements

Animal and clinical studies have found only minor increases in myoglobin or in CK (creatine kinase) [38–40]. The CK level increases were consistent with moderate exercise. A meta-analysis of four human studies included CEW exposure times of 5, 10, and 30 s. The median pre-exposure level was 148 (Inter-quartile range 87–479). Median increases in CK (at 24 h post-exposure) were 12, 26, and 47 respectively [41]. A recent multi-center study also found no clinically significant increases in CK [42]. Thus it does not appear that CEW applications can cause clinically significant rhabdomyolysis.

Acidosis has been reported from CEW applications in swine studies; however, the positive studies were in artificially ventilated and anesthetized swine that had the ventilator turned off during the prolonged CEW applications [38, 43, 44]. Human beings continue to breath and ventilate well during CEW applications whether across the chest, diaphragm muscles, or phrenic nerves in the neck [45–49]. This suggests that the unventilated anesthetized swine model does not give meaningful predictions extrapolatable to humans for acidosis. In fact, human studies demonstrate a minor alkalotic pH shift with the CEW application similar to that seen with moderate exercise, not acidosis.

Randomized studies have shown that a 10-s CEW application reduced acidemia in the already exhausted volunteer compared to the alternative of continued exertion from physical control techniques [50, 51]. In one study of 37 volunteers, pH change after a CEW application was compared to various length sprints and found to change the pH about the same amount as a 20 yard sprint (thirty yards is the distance from home plate to first base in the game of baseball) [52]. By denying the agitated subject muscle control, the CEW application likely reduces metabolic demands compared to the intense exercise of a struggle.

To determine the physiologic effects of the newly released TASER X2 CEW, researchers measured pH, lactate, potassium, CK, and troponin before and after a 10 s CW exposure in ten volunteers. There were no clinically significant changes in any of these parameters [53].

Massive electrical shocks, such as those from lightning or power lines, can cause cardiac cellular damage as evidenced by increased troponin levels [54]. Troponin levels have been measured in subjects before and after CEW exposures in numerous studies [40, 42, 48, 51, 55]. No statistically or clinically significant increases were found. A recent “best-evidence” review concluded that no cardiac monitoring was required for subjects in sinus rhythm after a CEW exposure [56]. The American Academy of Emergency Medicine Clinical Practice Committee published similar recommendations from their structured literature review on TASER CEWs [57].

Electrocution and Cardiac Issues

No topic regarding the use of CEW has generated more controversy than the possibility of CEW-induced cardiac issues. This seems natural considering the level of scrutiny associated with an arrest related death."Electrocution" is the term first coined in the late 1800s to describe the government's execution of a criminal by use of electricity. It was a contraction of "electrical execution." Today the term "electrocution" is more broadly used to describe the induction of a cardiac arrest by the application of, or exposure to, electrical shock. This has been the most theorized mechanism by which a CEW could allegedly cause death in a person.

Due to the frequent practice of ICD implantation, the electrical induction of VF is well studied. During the implantation process, the electrophysiologist will intentionally use electricity to induce a cardiac arrest [58, 59]. The ICD will then recognize the ensuing electrically induced VF and deliver a lifesaving electrical shock to verify the ICD's proper function. Table 8.1 lists the characteristics of electrically induced dysrhythmias that have been determined by cardiac electrophysiologists. Awareness of these characteristics informs efforts at determining the potential for CEWs to cause VF.

Computer Modeling

Numerous computer modeling studies have been done to evaluate the electrical current reaching the heart and the risk of the direct induction of VF by a CEW. The most exhaustive study was done by Holden et al. which suggested a very wide safety margin for the direct induction of VF [60]. When applied to the ventricles in trains designed to mimic the discharge patterns of CEW devices, neither the M26 or X26 TASER CEW model waveforms induced VF at peak currents >70-fold (for the M26 waveform) and >240-fold (for the X26) higher than the modelled current densities. The authors conclude that this provides evidence for a lack of arrhythmogenic action of the M26 and X26 CEW devices. Panescu et al. similarly found that electrical current density at the heart was significantly below that required to directly induce VF [61]. The Webster group reported that the risk of direct induction of VF from a CEW application, was 6 PPM (parts per million) [62]. However, that modeling data base was dominated by thin females and thus the 6 PPM stated risk

Table 8.1 Characteristics of electrically induced dysrhythmias established in the cardiac electrophysiology literature [95–99]

Ventricular fibrillation is either induced or not induced within 1–5 s
Cardiac rhythms of asystole and PEA (pulseless electrical activity) are not induced by the electrical pulses
The cardiac pulse disappears immediately
The patient loses consciousness within 5–15 s
A sufficiently strong defibrillation shock—either internal or external—restores a cardiac sinus rhythm 99.9% of the time
There is no increased risk of a delayed VF since electrical current does not linger, or build up, in the body as a poison or drug might

significantly exaggerates the risk in males. Webster's data relied upon skin to heart echocardiograms of 150 subjects. Of those 150 subjects, Webster stated that 8 of the 150 had a sufficiently narrow skin to heart distance for the induction of VF. Webster's paper fails to mention that of the eight subjects, seven were females. Thus, the probability of CEW directly induced VF in males is far less than Webster's stated 6 PPM. Clearly the male risk is <1 PPM (1/8 • 6 PPM).

Ideker et al. used transthoracic pacing data to predict the VF safety margin and estimated that the safety margin was 28:1 [63]. Multiple human studies using anterior chest applications have uniformly reported zero incidents of VF [50, 51, 64–66]. These studies included contra-lateral electrode placements to test primarily for respiration impairment. In addition other studies have used continuous echocardiographic monitoring and have not found VF [67–70]. Bozeman et al. combined published US data with UK Home Office data covering 4058 consecutively monitored CEW field uses in which the electrical current was actually delivered [71]. There were no cases of cardiac death related to the CEW usage. Panescu utilized computer modeling to determine the theoretical probability of inducing VF and concluded that it is significantly lower than 0.0000008, or 1:1,270,000 [72].

Minimum requirements for assessing of CEW electrocution are given in Table 8.2.

Table 8.2 Electrocution checklist to help discern if CEW exposure could have caused ventricular fibrillation

Present?	Not present	Criterion	Rationale
From law enforcement reports			
		1. Probe mode deployment (instead of drive-stun)	Drive-stun mode is not able to directly induce VF even in small swine [132, 162]
		2. Use of X26E CEW (as opposed to the newer X2, and X26P)	The X26E delivers a higher electrical charge compared to the other models (axon company info)
		3. Subject has cardiovascular collapse within 15 seconds (s) of *initiation* of a probe-mode application	The direct electrical induction of VF requires 2–5 s [95–99, 110] Subject collapse in VF occurs within 10 s of the VF initiation [163]
From EMS report			
		4. A defibrillator shock applied to the person within 8–10 min of VF terminates the VF. Law enforcement defibrillator may have been used	Electrically induced VF is terminated by a defibrillation shock 99.9% of the time (if delivered promptly) [99, 164]. After 12 min (with CPR) this falls to 88% [164]
		5. Cardiac rhythm seen within 30 min of the collapse is VF. This is demonstrated either by an external defibrillator announcing "shock advised" or by a paramedic's EKG recording	Most cardiac rhythms seen with acute or chronic drug effects or excited delirium are not VF [92, 165–168] After 30 min of a possible VF the rhythm may deteriorate to another type of dysrhythmia [127, 129]

(continued)

Table 8.2 (continued)

Present?	Not present	Criterion	Rationale
		6. Initial presenting rhythm is not asystole or PEA	Asystole and PEA cannot be induced with electrical stimulation. This criterion is not valid after 30 min from collapse as VF will eventually deteriorate into asystole or PEA [129]. Unsuccessful defibrillation shocks can convert VF into asystole or PEA but that is different
From autopsy			
		7. One probe was directly over a cardiac ventricle	When VF has been induced in the small swine, at least one of the probes was over a ventricle [132, 169]
		8. The probe directly over the cardiac ventricle penetrated the skin and did not simply penetrate or lodge in the person's clothing	VF has only been induced even in swine with a fully inserted probe [133, 169–171]
		9. Penetration of the probe through the intercostals in the left parasternal region	This would shorten the dart to heart distance
		10. The penetrating probe over the heart penetrated straight in and was not at an angle that would negatively affect the dart-to-heart distance	Webster group predicted, from porcine studies, that VF induction would require a very thin person with a full 9 mm barb penetration [169]
		11. The dart tip-to-heart distance is a maximum of 8 mm. For exposures of >90 s this critical distance is probably 15 mm [67] (15–20 mm in swine) [135, 136]	The most extreme distance found by the Webster group for VF induction—in swine—was 8 mm with an average of 6 mm, and a minimum of 2 mm [169]. Swine are easy to fibrillate and thus present a conservative model [172–174]

Items 3, 9 and 10 do not apply completely to situations of exposures >90 s

Safety Standards and Animal Studies

Two organizations, the Underwriters Laboratory (UL) and the International Electrotechnical Commission (IEC), specify safety standards for electrical fences. By their standards, the various models of TASERs, including the current X2 and X26P models, deliver a safe level of electrical power [73–76]. Modern CEWs deliver a current of approximately 1.8 mA pulsed DC and the limit is 2.2 mA. 1.8 mA is equivalent to 16 mA of AC which is lower than the IEC 40 mA safety limit.

However, the electrical fence safety standards assume external skin contact. The heart is closest to the skin at the fourth or fifth left parasternal intercostal space where the depth can be as small as 18 mm in a thin male or 12 mm in a female [77]. Therefore, it is implied that a 10 mm dart to heart (DTH) distance is generally considered an approximate minimum safe distance between the probe and the heart [78].

Swine studies have been used extensively to determine the risk of ECW induction of VF. However, they have limited generalizability. Swine have longer QT intervals and a short repolarization reserve compared to human [79, 80]. Additionally, swine have intramural Purkinje fibers which make them more sensitive to external electrical stimulation. Humans have Purkinje fibers that are located on the inner musculature of the heart, whereas swine have the electrically conducting Purkinje fibers throughout all layers of the heart making the conducting tissue closer to the surface of the heart, increasing the likelihood of conducting an exogenous source of electricity into the swine heart [81, 82]. Also, swine are, in general, smaller than humans, particularly the swine that were used for CEW research purposes. This is important because the current required to cause harm is weight related. The larger the subject, the higher the current required to induce VF [83].

Thus, swine are excellent models to study the electrical behavior of VF but are not great models to study VF thresholds in humans. Despite this, even in all of the swine studies involving CEWs, induction of VF was incredibly rare. In a review of all swine studies examining the risk of inducing VF with an CEW, there have been over 7500 standard CEW activations in swine, with 745 cases of cardiac capture reported. Recall that cardiac capture is depolarization of the cardiac electrical circuitry in response to an electrical stimulus. And out of all of these CEW activations and even fewer episodes of cardiac capture, there have only been six cases of VF induced in swine [83]. Of these six cases of VF, five started immediately after the CEW activation stopped. In one 29 kg pig, after 80 s of a CEW application (two 40-s activations) in which the ventilator was shut off, there was one episode of VT that started immediately after the CEW activation was stopped and then approximately 3 min later it degenerated into VF [84]. This is the only reported case of cardiac capture leading to VF that did not start immediately at the time of the CEW activation.

Additionally, these six cases all have confounders which limit their applicability to humans in general and ARDs specifically. VF was not induced in any swine weighing more than 36 kg using an isolated CEW discharge. A single case of VF occurred in a 50 kg swine who was simultaneously receiving an epinephrine infusion [83]. Recall that epinephrine lowers the VF threshold during and for several minutes following administration. There was one case in which the pig was subjected to a thoracotomy and the CEW activations had more direct access to the cardiac tissue.

Investigators have taken the swine data, and using correction factors, made VF induction risk estimates for humans. It is estimated that the VF risk is approximately one in three million probe uses. The critical DTH is estimated to be approximately 3 mm. Lastly, the lower limit of body mass for safety is approximately 21 kg in humans [78]. Put simply, these projections estimate that for an CEW to induce VF in a human, the probe has to hit the chest in the exact right place, the heart has to be very near (~3 mm) the probe, and the patient has to be very small. These are all unlikely events.

Human Data

There have been a number of human studies and the human data are consistent with these estimates. In laboratory studies, 66 humans have been intentionally exposed to a CEW discharge with precordial probes. During continuous ECG or echocardiographic monitoring, there were no cases of VF and only one case of cardiac capture during the activation. This one case reverted to sinus rhythm with the cessation of the CEW activation [85–87]. Of note, in the one case where there was cardiac capture, a prototype ECW was used; this model was never manufactured and sold. Other studies have also used transcardiac placement of probes without any negative cardiac effects reported [65, 88, 89].

As of January 2019, the primary manufacturer of CEWs reported 3.9 million field uses. A probe lands in the anterior chest in 49% of field uses [10]. There have been twelve case reports that suggest a CEW induced electrocution. Thus, the incidence of CEW induced electrocution in the field is approximately 6.3×10^{-6}.

Kroll examined these twelve cases in more depth [90]. Seven criteria were used to assess a general probability that the CEW induced VF. These criteria are useful when trying to determine a causal relationship between a CEW discharge and the induction of VF. The first criterion was the presenting rhythm. A patient presenting with asystole or PEA is unlikely to have had VF induced by a CEW because these rhythms are not inducible with electrical stimulation [91]. These rhythms are more consistent with drug overdoses or excited delirium [92, 93]. Also, VF does not progress to asystole as rapidly as typically thought; in swine studies, the median time for deterioration is 34 min [94] (2012 Kroll the stability of electrically induced ventricular fibrillation).

The second criterion is the DTH distance. Recall that, based on models derived from swine studies, the critical DTH distance is approximately 3 mm in humans. That is, the probe tip of the CEW, needs to be approximately 3 mm or less away from the epicardium to induce VF [78]. 8 mm was used in Kroll's analysis as a more conservative estimate [90].

Third, a documented pulse after CEW discharge makes an electrically induced VF unlikely. Studies in patients in the electrophysiology lab show that VF is either induced or not induced within 5 s, and that the pulse is lost immediately [95–99].

Next, patients who have VF very quickly stop breathing. Normal breathing should cease soon after the induction of VF but can have agonal breathing for up to 6 min [100–102]. In some of the case reports, normal respirations were recorded several minutes after CEW discharge but prior to collapse, which is inconsistent with CEW induced VF.

Fifth, electrically induced VF should respond promptly to defibrillation attempts. With chest compressions, defibrillation has a 90% success rate after 10 min of electrically induced VF with <3 shocks [103]. VF resistant to defibrillation is more consistent with underlying cardiac or metabolic disease and not electricity induced VF.

The last two criteria to consider are cardiac pathology and the findings of the medical examiner. Cardiac pathology, such as a prolonged QT interval or coronary artery disease, complicate the case for causation. And while medical examiners/ forensic pathologists may not be specialists in electrophysiology, they are central to death investigations and their impressions can be relevant.

In his review, Kroll found that the twelve cases all had characteristics that were inconsistent with electrically induced VF [90]. A case consistent with electrically induced VF would be a thin patient without underlying cardiac or metabolic disease who receives a probe in the left chest and immediately collapses. There should be no detectable pulse, breathing should cease within minutes, the presenting rhythm should be VF, and it should respond promptly to timely defibrillation.

Illustrative Case Chicago police officers and paramedics were called to a high-rise apartment building where the subject was naked and noted to be talking to aliens on his cellular telephone. Police officers used a TASER X26 CEW to attempt to get the subject under control. After application of the CEW, he was handcuffed and helped to climb into the paramedics stair-chair. Paramedics then verified the subject's pulse and respiration. Police and paramedics agree that he was alert and breathing—with eyes open—as he was wheeled into the elevator.

At the ground level of the high-rise—8 min after the CEW applications, the subject was unresponsive, found to be in VF and aggressive resuscitation therapy was given unsuccessfully. The subject was pronounced deceased in the hospital about 60 min later. Toxicology later showed a blood methamphetamine level of 0.55 μg/mL.

The local deputy medical examiner (DME) blamed the CEW as the primary cause of this individual's death in his autopsy report stating that the death was by "*electrocution"* from the CEW (with the contribution of methamphetamine) [104]. Material concerns regarding this autopsy conclusion include: (1) blaming the CEW when the subject had normal pulse and respiration after the application as the electrical induction of VF causes loss of both within seconds, (2) relying on an unsupported speculation of a dysynergy between electrical current and methamphetamine, (3) ignoring the 8-min gap between the CEW application and the collapse, (4) ignoring the subject's alertness minutes after the CEW application, and (5) ignoring the failure of defibrillation shocks.

An additional concern was raised years later when the DME, admitted under oath, that his supervisor had suggested the term "electrocution. There were speculations of conflict with the supervisor [105].

Ventricular Fibrillation, Commotio Cordis, and Cardiac Capture

VF can be induced by sufficiently strong electrical current flowing through the body. The current that is required to directly induce VF is dependent on the length of time, but only up to a few seconds. It is well established that the direct

VF induction threshold decreases for the first few seconds and does not decrease further [95, 96, 106–109]. In other words, if a person is not put directly into VF by a certain level of electrical current after 5 s, the person will not be electrocuted by a 60+ s exposure either [110]. Both the International Electrotechnical Commission (IEC) and the Underwriters Laboratories (UL) regulation's recognize that electrocution either happens in the first few seconds or does not happen [111]. Electrical currents that will not directly induce VF in 5 s will not induce VF in 1 min [110].

Animal studies going back to the 1930s show that the risk of inducing VF does not build up (increase) after the first few seconds. The duration (critical time) is the time at which further applications of electrical current do not increase the risk of directly inducing VF. These studies have found that the critical time ranges from 0.8 to 5 s [95, 96, 106–109]. Based on the animal results above, Biegelmeier and Lee calculated that the critical time ranged from 2 to 5 s for humans due to the lower heartrate [95, 96]. More recently Swerdlow et al. demonstrated that the human VF threshold (VFT) dropped dramatically when going from 0.5 to 1.0-s long applications [112]. The VFT fell by another 54% going from 1 to 5-s applications consistent with the Biegelmeier predictions.

A sharp blow over the heart can induce VF via the mechanism of commotio cordis, in which blunt trauma mechanical shock occurring during the "vulnerable" period of the cardiac rhythm could cause VF [113]. This is associated with energy levels of 380 J (rubber bullet) or 540 J with a plastic bullet. Rarely, but tragically, it is reported in young people with a 13 J impact over the heart during the so-called vulnerable period T-wave. However, the CEW probe kinetic energy (1.5–2.2 J) is far too low to induce commotion cordis [114–116].

The suggestion that the CEW could induce VF by shocking in the vulnerable period of the heartbeat cycle has been referred to as "Russian Roulette," "Lightning Lottery," or the "Tailspin." [117–119] The most vulnerable section of the cardiac rhythm is the first half of the T-wave and this lasts about 54 ms on average in humans [120]. The X26 CEW puts out 19 pps. That means that the spacing between pulses is 1/19th of a second or 52.6 ms. In other words, for the average individual, no vulnerable period escapes the X26 CEW pulsing—the X26 CEW pulse hits every T-wave. If this was the mechanism for VF, basically every transcardiac probe deployment should be able to cause VF, which is obviously not the case based on the epidemiologic data.

The presenting cardiac rhythm with ARDs is most commonly either brady-asystole or PEA—rhythms that are typically associated with excited delirium or drug overdose deaths [121–125]. A natural concern is whether or not there may have been electrically induced cases of VF which deteriorated to asystole. This appears to be unlikely for several reasons. First, in the majority of the cases reported by Swerdlow et al. the cardiac rhythm was documented within 5 min. Secondly, in many of the other cases, the EMS was present about the time of the LEOs arrival and were staged waiting for the officers to gain control of the subject. In many of these cases, LEOs applied their own AED (automatic external defibrillator) which reported "No shock advised" thus eliminating VF as the presenting cardiac rhythm. Finally, the time course of VF deteriorating to asystole—from electrically induced VF—is far longer than generally appreciated. Studies of canines, swine and sheep have found no deterioration to asystole from electrically induced VF out to the limits of their monitoring time of 10 min [126–128]. In one study designed specifically to determine the stability of electrically induced VF, six swine were observed after VF was electrically induced. In all swine, VF lasted at least 24 min before deterioration to asystole and the median duration of VF was 34 min [94].

In the one clearly documented human case of the deterioration of electrically-induced VF into asystole the time required was 34 min [129]. Human beings have been kept in VF for over an hour with cardiac massage without deteriorating into asystole [130]. Most LEOs are trained to administer chest compressions in the event an individual goes into cardiac arrest. This would likely further extend the time for deterioration of VF into asystole.

Long-term high-rate cardiac capture has also been hypothesized as a possible mechanism for the induction of VF in a field situation. This is an issue worthy of examination as high-rate cardiac capture will occur at electrical current levels about 1/3 of those required to directly induce VF. High-rate cardiac capture is commonly seen in small swine when the CEW probes are placed deeply and close enough to the heart [131–133].

For background it should be noted that there is nothing intrinsically dangerous about long-term cardiac capture. Cardiac capture, after all, is how pacemakers keep pacemaker patients alive. However, if the electrical current delivered to the heart was strong enough to cause high-rate capture (220–280 BPM) there would be a significant loss of cardiac output. This could eventually lead to VF when the ischemic acidosis sufficiently lowered the VFT. The median time for this to occur has been variously reported as 1.5–4 min (90–240 s) [134–136]. A canine study found that it could not occur in 60 s but the study durations did not extend beyond 60 s [110]. As mentioned prior, out of 745 cases of capture in the swine literature, there have been only six cases that degenerated into VF. All of these cases occurred in severe conditions not present in human field use [83, 84, 135].

Long before the high-rate cardiac capture could induce VF, the subject would show evidence of a significant drop in cardiac output, such as syncope. This would cause the subject to stop fighting and resisting within 5–10 s of the CEW application. From a physiologic standpoint, such a scenario would play out as follows:

1. A violent subject receives a CEW probe discharge over the heart.
2. The subject is thin and a relatively precise probe placement and penetration depth obtains allowing high-rate cardiac capture.
3. The high-rate cardiac capture causes syncope within about 10 s.
4. The subject collapses to the ground and stops resisting.
5. The LEO unnecessarily holds the trigger back for approximately 2 min in spite of the fact that the subject stopped resisting at 5–10 s.
6. The subject experiences VF

Published echocardiographic studies with chest application studies in humans (with either probes or EKG electrodes) have not reported cardiac capture [67, 69, 70]. And thus, there has never been a documented case of cardiac capture in a human leading to sustained VT or VF.

Other Considerations

Pacemaker and Implantable Cardioverter Defibrillator Patients

Pacemakers and Implantable Cardioverter Defibrillators (ICDs) are required by international standard to withstand the 360 J (joule) shock of an external defibrillator, lasting approximately 10 ms (milliseconds), and protection circuits have been incorporated to prevent damage to electronic components from transthoracic shocks [137]. The X26 CEW delivers about 0.1 J per pulse. Thus, pacemaker and ICD protection circuits have an ample safety margin (3600:1) to protect against X26 CEW discharges. New models including the X2 and X26P have similar energy pulses. Nevertheless, transthoracic defibrillation shocks can reprogram and occasionally damage pacemakers if a defibrillation electrode is placed directly over the pacemaker's pulse generator. However, no investigators have identified reprogramming of or damage to pulse generators as a result of CEW discharges [138–140].

Newer ICDs have sophisticated circuitry and should not pass voltage from a CEW down its lead into the heart. However, ICDs can potentially misinterpret the rapid pulses of a CEW as a cardiac dysrhythmia such as VF. Haegeli et al. reported such a case in a 51 year old female ICD patient with an "integrated bipolar" lead [139]. Such a lead is more sensitive to interference compared to the "true bipolar" lead [141]. Probes struck the woman in the sternum and the pulses were mistaken by the ICD as VF. The ICD began the 8–10 s charging process to deliver a shock; however, by the time the device was charged, the CEW application was over and the ICD went back to its normal monitoring operation without delivering a shock. While there is a risk of an ensuing shock delivery, this is unlikely because the typical CEW application is shorter than the typical ICD detection and capacitor charge times. A systematic review found two other instances where an ICD misinterpreted a CEW shock as VF, but no shocks were delivered [78].

Pacemaker circuitry is different than ICDs, and there is a theoretic risk that the pacemaker lead can act as an "antenna" to deliver CEW pulses into the heart. The CEW pulses could then act to pace the heart and theoretically induce cardiac arrest. This has not been reported.

Despite several million field uses, there are only several recorded CEW exposures in pacemaker patients. Cao reported a case of an X26 CEW cardiac capture in which the CEW discharge was delivered into the chest of a rioting prisoner with a pacemaker [138]. In another case series, two pacemaker patients were exposed to a TASER CEW application but experienced no symptoms of rapid pacing and pacemaker interrogation showed no untoward effects [142].

Fortunately, while there is a small risk of an adverse event for pacemaker and ICD patients when exposed to a CEW, these interactions are infrequent due to the significant age difference between the typical resisting subject requiring CEW control methods (30 ± 10 years) [9] and pacemaker patients (first implant 75.3 ± 11.1 years) [143].

The most common ICD-CEW interaction is detection of the CEW pulses as rapid oversensing, which should put the pacemaker into noise reversion (fixed-rate) mode for the duration of the application. This has not been demonstrated in swine models looking at pacemakers nor reported to have occurred in a humans [144, 145]. Moreover, fixed-rate reversion would prevent a drop in cardiac output and any resulting clinical manifestations such as syncope.

Illegal Stimulants

There have been a number of speculated potential morbidities associated with the CEW. Suspects presenting with excited-delirium type behavior tend to have rhabdomyolysis and acidosis and many also have cardiomyopathies from their chronic abuse of cocaine, methamphetamine, or alcohol [146–148]. Hence there has been concern that CEW application could cause or exacerbate these conditions.

Given the inherent risk of illegal stimulants, some have assumed a potential synergistic interaction with CEWs placing humans at greater risk of cardiac injury or death. This contention does not appear supported by current research. It is well documented that cocaine has strong effects on the heart such as dramatically raising the heart rate and blood pressure [149]. Chronic cocaine usage also significantly increases the risk of a myocardial infarction [150] and cardiac arrest [151]. Thus, the natural "medically intuitive" assumption is that the presence of cocaine also makes it easier to electrocute someone and electrically induce VF.

However, most scientific studies have shown that cocaine makes electrocution more difficult, not easier [152–154]. This is due to the sodium channel blocking effects of cocaine which makes it much harder to stimulate a heart cell. This has been confirmed using actual X26 CEW waveforms [155]. The VF safety margin went up significantly with the presence of cocaine and was almost doubled for probe barbs near the heart.

Cardiac electrophysiologists routinely use intravenous stimulants (such as isoproterenol) to induce ventricular tachycardias in their electrophysiology labs. Hence, a typical first blush reaction is to assume that stimulants increase the risk from a CEW or external electrical shock in general. However, stimulants, including isoproterenol, tend to actually increase the amount of electrical current required to induce dysrhythmias [156]. The same is true with other stimulants such as phenylephrine [157].

Direct catecholamine exposure appears to only lower the VF threshold for the first 3–7 min, which in an ARD (arrest-related death) is usually *before* the arrival of law enforcement and EMS (emergency medical services) to a call for strange or bizarre behavior, after which time the VFT (VF threshold) actually goes up [158].

Note that this field CEW application situation is far different from someone quickly ingesting a large drug dosage in front of LEOs and then struggling against the officers' attempts at capture, control, and restraint. That could be dangerous with some stimulants for the first few minutes as was shown in an absolute worst case situation of low body weight, barb inserted under the skin, barb placed over the heart, barb penetrating the intercostal muscles, and a strong pure stimulant (epinephrine—with no protective effects such as those of cocaine) given intravenously [133].

There is concern that drug abusers using methamphetamine and other illegal stimulants could be at increased risk for electrocution from the CEWs. However, a small animal study found no CEW induced VF even in the presence of various similar stimulating agents [159]. Also, a large study from the UK (United Kingdom) Home Office found no increase in risk with common drugs [160]. In a study of 16 sheep, cohorts of sheep were exposed to escalating doses of methamphetamine, then exposed to a CEW discharge. After the CEW discharge, two sheep developed supraventricular tachycardia, one had a premature atrial contractions, and one had non-sustained ventricular tachycardia. None developed VF. These were all in smaller animals; CEW induced dysrhythmias were associated with weight, but not exposure to methamphetamine [161]. Overall, there does not appear to be an increased risk of cardiac dysrhythmia or sudden cardiac arrest when CEWs are used in subjects using illicit drugs.

Clinical Management

The clinical management of patients exposed to a CEW discharge is straightforward: patients should be assessed with a history and physical which will guide further therapy. A 2010 clinical practice guideline concluded that since CEW exposures do not lead to delayed cardiac ischemia or dysrhythmias, the literature does not support routine performance of electrocardiograms, prolonged ED observation, or hospitalization for ongoing cardiac monitoring after CEW exposure in an otherwise asymptomatic awake and alert patient. It also concluded that the literature does not support routine performance of laboratory studies to detect metabolic abnormalities [57]. Subsequent findings, as presented in this chapter, have reinforced this recommendation. Put simply, CEW exposures do not lead to occult or delayed findings.

Many of these patients will have underlying medical conditions such as intoxication, psychosis, excited delirium, or traumatic injuries that will require further care. A small portion will need further care to address CEW injuries in sensitive areas including the face, hand, or genitals. However, these conditions will be evident on exam and are no different from the many arrest-related conditions addressed by the law-enforcement system daily.

There is no global standard of care for these patients and protocols vary; however, some type of assessment is recommended. This can be accomplished in a variety of ways and is often completed by EMS personnel in the field, by a medical screening at a jail facility, or in the Emergency Department.

Conclusion

Conducted electrical weapons are an important tool for LEOs when confronting violent subjects. Serious injuries from their use are rare and are usually minor and straightforward for the examining clinician. Determining if a CEW exposure has caused a death by inducing a lethal dysrhythmia is less clear. While this event is theoretically possible, it is highly unlikely. We recommend a systematic, evidence-based approach to making this clinical determination. Table 8.2, designed to help pathologists address the specific question regarding the causation of VF, can help in this area.

Key Points

- Significant injuries from CEW exposure are uncommon but include wounds from the direct trauma of probe penetration, traumatic injuries from falls caused by muscle incapacitation, and very rarely burns from ignition of flammable substances.
- Ventricular fibrillation and sudden cardiac arrest are highly unlikely to be caused by a CEW exposure. Use the included checklist to assess for possible causation.

Self-Assessment Exercises

1. List the conditions consistent with CEW induced ventricular fibrillation.
2. List the potential traumatic injuries that can occur secondary to CEW exposure.

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Care of Detainees

9

Margaret M. Stark, Alex J. Gorton, and Patrick Chariot

Learning Objectives
Demonstrate the ability to manage the common presentations of physical illness (asthma, epilepsy, diabetes) in custody.

Describe the safe administration of medication in custody settings.

Explain the management of specific individuals in custody: children, those suspected of terrorist offences, suspected internal drug traffickers.

Assess detainees with mental illness at risk of self-harm.

Introduction

Healthcare professionals (HCPs) may be requested by the police to assess the fitness for detention in police custody of adults and juveniles arrested in connection with an offense; those detained by immigration; individuals requiring a place of safety (children, vulnerable adults, and the mentally ill); remanded or sentenced (convicted) prisoners; or those detained under terrorism legislation. In some areas they may also be asked to assess complainants/complainers of crime.

Detainees in police custody may have to be interviewed regarding their involvement in an offense and possibly further detained overnight for court; guidance may therefore have to be given to custody staff regarding their care.

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There are a variety of terms used to describe the individuals that HCPs may care for in the custody setting. These terms include patients, detainees, detained person (DP), suspects, arrestees, clients, or even customers. It is helpful to think carefully about the language used as this may impact on the direction an assessment takes. The authors tend to prefer to utilise the terms patient or detainee. The first term emphasises a clinical relationship, whilst the second reminds HCPs that the individuals in front of them are in an unusual situation for most patients. They have lost a degree of autonomy by being brought into custody, are often under increased stress, and may be suspicious of authority figures. Bearing these factors in mind can only enhance the quality of the clinical assessment being undertaken. Throughout the rest of this chapter, individuals in police custody will be referred to as a detainee.

Although various laws govern the powers of the police in different jurisdictions [1], the basic principles remain the same [2–4]. It is essential that custody staff perform a risk assessment when an individual is detained in police custody [5].

Significant health concerns among police detainees have now been recognised [6–8]. In recent years the assessment of the health needs of detainees in police custody in England and Wales has indicated that mental health problems including substance misuse and physical conditions are highly prevalent among the custody population requiring both emergency and routine care [9]. Mental health concerns and depression account for up to 20% of patients assessed in London [6, 10]. The importance of recognising dual diagnosis (comorbidity) has also been highlighted in this population [11]. In a study in The Netherlands of detainees obtaining medical attention in police custody almost 50% were diagnosed with mental health problems with substance abuse as the leading reason for the consultation. The authors concluded that the magnitude of mental health problems among police detainees has significant implications for the qualifications of police health staff and those provide healthcare in the police setting especially concerning substance abuse [12]. In Germany a study of medical examinations to determine whether a person is fit to be detained in custody indicated in the majority of cases problems with acute alcohol intoxication or drug withdrawal, trauma, and internal or mental diseases. In 40% of cases were detainees found to be unconditionally fit for detention and just under 10% the person was found unfit to be detained in custody [13].

An evaluation of the efficacy of the current risk assessment screening in London, UK, found that a high prevalence of a range of health disorders were not identified [14]. A modified screening process was developed and demonstrated improvements in the rate of detection of significant health morbidity by custody officers while also reducing the number of detainees needlessly referred for the attention of HCP [15].

Detainees who are identified as:

- Suffering from a mental illness
- Suffering from a physical illness
- Needing medical attention
- Having sustained any injuries (either at or prior to arrest)

should be referred for clinical attention as soon as possible, whether or not the detainee requests an assessment [16]. Furthermore if the detainee's behaviour gives rise to concern, medical advice should be sought [17].

Custody staff should also seek medical advice where [16]:

- a detainee requests a medical assessment
- requires medication
- if they suspect the detainee is suffering from an infectious disease and they need advice
- a detainee has in their possession or claims to need, medication for a heart condition, diabetes, epilepsy or a comparable condition.

In some areas, when a person under arrest is discharged from the hospital and taken to a police station, a HCP will be called for advice as to whether the detainee is fit to be detained and fit to be interviewed.

In 2003, the term healthcare professional was introduced in the UK. It refers to a: Clinically qualified person, who is working within the scope of practice as determined by their relevant professional body and who is registered with that body as competent to practice [18]. This term has been used in the Codes of Practice of the Police and Criminal Evidence Act 1984 (PACE) since 2003. Since its introduction the majority of teams working within police custody in the UK are multidisciplinary, comprising of nurses, paramedics and doctors. It is essential that any initial training is to the required standard and continuing professional development is maintained [19, 20]. National Occupational Standards have been defined for the healthcare service provision in police custody in the UK [21] and there are also French national standards available [22].

Clinicians working in police custody, a lone and autonomous role professionally, should be supported by robust clinical governance procedures to ensure competence in this high-risk environment [23, 24]. Nurses and paramedics working in this setting are expected to make clinical decisions and risk assess at a level broadly equivalent to advanced nurse practitioners in Emergency Departments and therefore should receive similar training and qualifications to practice independently. The quality of current healthcare provision in the police custodial environment in the UK is extremely variable and there is a need for improvements to ensure that the HCPs working in this area are competent to provide a quality of care that is of equivalence to that of the wider community.

The health and welfare of detainees should be paramount, with any forensic considerations of secondary importance [25]. The role of any healthcare professional in this field, as in any other healthcare situation, should be independent, professional, courteous, and non-judgmental [26].

If the police bring a detainee to the emergency department or if the HCP is contacted by custody officers to attend the police station, it is important to find out the reason why a clinical assessment is required. It is essential that the HCP is properly briefed by the custody staff or investigating officer (Table 9.1).

Informed consent from the detainee should be obtained after explaining the reason for the examination. The Faculty of Forensic and Legal Medicine of the Royal College of Physicians of London have several proform as for forensic examinations and for obtaining consent that are readily available to all HCPs (www.fflm.ac.uk).

It should be stressed that the detainee is not obliged to consent to an assessment. It should also be stressed that there is no right to absolute confidentiality and it should be explained that this is no different to any other healthcare setting where disclosures may be required. Notwithstanding the latter, custody staff should only be given the information necessary for them to care for detainees while they are in police detention. Such information would usually include details of any medical concerns, required observations, medication, and dietary requirements. It may be useful to explain that although generally medical information will remain confidential (with the caveats above) information may be shared to keep the detainee safe whilst in custody (see Chap. 2).

It is essential that a full clinical assessment is performed and detailed contemporaneous notes made. Obtaining an accurate account of a detainee's drug history, including prescribed and illicit drugs, can be difficult. A useful aid to obtaining a better drug history has been described (Table 9.2) [27].

Table 9.1 Briefing on arrival

Discuss reason for being called (physical or mental illness/medication/injuries)
Obtain details from the custody record and any risk assessment performed by police personnel or other healthcare professional, including the reason for arrest (may be related to drugs/mental illness)
Ask the arresting officer for information regarding the circumstances of arrest (concerns regarding behaviour/use of force)
Other information may be obtained from relatives/friends/family doctor/hospital/police national computer/database
Whether any force was used: handcuffs, incapacitant spray, batons, conducted electrical weapon, etc.
Whether anything found in the detainee's property or when searched (medication, illicit drugs)
Any concerns about detainee's behaviour or personal safety
Is the request to assess fitness for detention only?
The anticipated length of detention, if known, is the detainee likely to be in custody overnight
Is the detainee to be interviewed?
Are any forensic samples required?

Table 9.2 The drugs mnemonic from Hocking et al.

Doctor	Any medication prescribed by a registered medical or dental practitioner
Recreational	Tobacco, alcohol, illicit drugs, anabolic steroids, etc.
User	Over the counter purchases/alternative medicine/homeopathy
Gynaecological	Contraceptive or hormone replacement treatment
Sensitivities	Including the exact nature of the response

The length of time a detainee spends in custody is important in determining a management plan. Many conditions that would not cause an issue during a short stay may require more complex interventions if detainees spend longer in custody. In the last few years the average duration of a detainee's custody stay has gradually increased in the UK from 6 h in the 1990s [28] to 11 h in 2015 [29], posing increasing challenges to the HCPs working in the setting. There is no evidence of an increased duration of detention in other countries, including France. There is also a general shift towards police forces in the UK preferring to have a HCP on site in custody.

The above two factors have contributed to a shift in focus from simply keeping someone alive during their stay in custody to ensuring that a more holistic approach is taken [30]. Increasingly there is an emphasis on liaison with appropriate services (including substance misuse teams, housing, women's pathfinder schemes, and criminal justice mental health liaison teams). By encouraging engagement with these services the aim is to reduce reoffending and divert appropriate individuals away from the criminal justice pathway.

Administration of Medication

As previously described the standard of clinical treatment in custody should be equivalent to that provided in non-custodial settings. Thus, wherever safe and practical a detainee's medication should be continued whilst in custody to ensure their safety and wellbeing. In some cases, however, it may be appropriate to adjust doses of existing regimes or even withhold them following a clinical assessment. Wherever possible this should be done in consultation with the detainee.

Historically some HCPs and organisations have imposed a '6-hour rule' barring administration of medication to detainees for the initial period after arriving in custody. This is clearly inappropriate and decisions to administer or withhold medication based on perceived risks of pre-arrest ingestions should be made on a case by case basis following a clinical assessment of the detainee. The same applies to considering risks and benefits of administering medication to detainees under the influence of drugs or alcohol.

In addition to previously prescribed medication, detainees may require additional treatment whilst in custody such as analgesia for headaches or minor injuries, or medication for symptoms of withdrawal from alcohol or drugs.

HCPs should ensure that clear, detailed information regarding any medication administered whilst the detainee is in police custody (including the dose, times of administration, and special instructions) are given to custody staff [31] and entered on the custody record.

Nurses and paramedics may use Patient Group Directions which are defined as:

> a written instruction for the supply and/or administration of a licensed medicine (s) in an identified clinical situation signed by a doctor or dentist and a pharmacist. It applies to groups of patients who may not be individually identified before presenting for treatment [32].

Prescribers (usually forensic physicians, occasionally nurse prescribers) may prescribe medication for detainees, either via private prescriptions, or from stock held by the police or outsourced provider. Where medication is prescribed a sufficient quantity of medication should be prescribed to cover the anticipated time in detention. With embedded models of healthcare this is likely to be administered by the resident HCP.

Medications may be left by prescribers in appropriately labelled individual containers or sachets. Officers can, with appropriate safeguards, then supervise the detainee's self-administration of prescribed medication.

It is vital that there is a safe regime for the administration of medication to detainees. Records should be kept showing that the prescribed medication is given at the correct time and that any unused medicines are accounted for. Medication should be stored in a locked cupboard. Ideally, police personnel should ensure that when administering medication, they are accompanied by another person as a witness and the detainee should be observed taking the medication to prevent hoarding.

If detainees are arrested with medications on their persons, medical advice should be sought as to whether they should be allowed to self-administer this medication. It may be prudent for an assessment by a clinician to be performed either in the custody suite or in the local hospital prior to self-administration.

Medication brought with the detainee or collected from the home address should be checked to ensure that it has the correct name and dosage and that the quantity left is consistent with the date of issue. If there is doubt, checks should be made with the pharmacist, family doctor, or hospital, previous custody notes/computer log entries. If the medicine is unlabelled, it is preferable to issue a new prescription, especially with liquid preparations such as methadone. Consideration should be given to supervising injections such as insulin.

Illustrative Case *The HCP was asked to review a detainee who had been in custody for about 6 hours. She had been interviewed, charged, and was due in court the next day. She was known to be a heroin and crack/cocaine user with mental illness, on medication. The custody staff requested an assessment with regard to whether she required any medication. During the consultation with the HCP the detainee became increasingly drowsy. On direct (persistent) questioning the detainee said she had taken:*

- *Temazepam 10 mg x8 (prescribed 10 mg at night)*
- *Quetiapine 200 mg x6–7 (prescribed 200 mg each day)*
- *Tramadol 50 mg x10 (not normally prescribed)?Slow Release*

Examination revealed she was not fully alert but drowsy/rousable to voice, respiratory rate was 10 per minute, oxygen saturation 98% which fell to 94% on air, P87 decreased to 74 and BP 113/76 (possibly low). An emergency ambulance was called and she was transported to hospital for further assessment, observation and treatment for a suspected overdose.

Table 9.3 Additional Juvenile Risk Assessment (Gorton AJ)

Custody issues	Have you ever been in custody before? Do you understand why you're in custody? Does your parent/guardian know you're in custody? Do you feel safe whilst in custody?
Schooling	Are you in full time education? If no, how old were you when you left school, and why? What type of school do/did you attend? (Explore if they had any additional support, what type of class were they in? Where they bullied at school?
Relationships	What is your relationship like with your parents? (Are they able to talk to their parents if they are in difficulty? Is there any violence in the house? Are there issues with parental substance misuse?) Who lives with you at home/where are you living? (If in care, what type of housing? Who else is there? Are you coping in that environment?) Do you have friends who you can talk to if you are struggling? (If the HCP has any concerns regarding child sexual exploitation this may be an appropriate point to explore if these relationships are age appropriate.) Have you ever been at risk of, or suffered physical or sexual abuse? (Has anyone tried to touch you in a way that you weren't comfortable with? Would you know what to do/who to tell if someone did?)

Children in Custody

Increasingly, forces in the UK are requesting additional assessments for children (those under 18 years of age) in custody. This aims to identify any safeguarding issues at an early stage. In some countries, a medical examination is systematic for teenagers under 16 years [33, 34]. Although there are currently no formal recommendations as to what these assessments should contain, a suggested scheme is given in Table 9.3.

Conditions of Detention

The HCP should ensure that the conditions of detention are satisfactory with regard to the temperature, ventilation, and cleanliness of the detention cells, bedding, as well as the detainees personal hygiene, dietary needs, and fluids [4, 35]. The detainee should have access to food and fluids as appropriate and should also have a period of rest of 8 h during each 24 h [16].

Medical Problems

A number of common medical problems are encountered when the HCP is assessing fitness to be detained in police custody. These are now considered in more detail (Table 9.4). Substance misuse including alcohol, is fully discussed in Chap. 12.

Table 9.4 Common medical problems

Epilepsy
Asthma
Diabetes
Heart disease
Hypertension
Sickle cell disease
Injuries
Infectious diseases
Mental health
Self-harm
Claustrophobia
Pregnancy
Detainees who refuse nourishment
Substance misuse including alcohol

Epilepsy

Many detainees state that they have "fits" and there is a need to differentiate, if possible, between epilepsy and seizures related to withdrawal from alcohol or benzodiazepines; it is also important to consider hypoglycemia.

The type of seizure should be ascertained together with the frequency and date of the most recent one [36]. Details of medication should be obtained including time of the last dose. Treatment may be given if the detainee is in possession of legitimate medication; however, if he or she is intoxicated with alcohol or other central nervous system depressant drugs, treatment should generally be deferred until the detainee is no longer intoxicated.

The custody staff should have basic first aid skills to enable them to deal with medical emergencies such as what to do when someone has a fit. If a known epileptic has a seizure while in custody, a medical assessment is advisable, although there is probably no need for the detainee to be transferred to hospital. However, if a known epileptic has more than one fit or a detainee has a "first-ever" fit while in custody, then transfer to a hospital is recommended.

Convulsive Status Epilepticus (CSE) is a medical emergency, defined by tonic clonic seizures persisting (or recurring without recovery) beyond 5 min, with an increasing risk of morbidity and mortality if not controlled by 30 min. Treatment should be initiated at 5 min [37].

In custody, HCPs should have access to rectal diazepam or buccal midazolam for prolonged or repeated seizures [38]. Any detainee requiring parenteral medication to control fits should be observed for a period in the hospital.

Asthma

Asthma is a common condition. A careful history, including asking about recent exacerbations and hospital admissions, and objective recording of simple severity markers such as pulse and respiratory rate, blood pressure, speech, chest auscultation, mental state, and peak expiratory flow rate should identify those patients who require hospitalization or urgent treatment [39, 40]. Asthmatics should be allowed to retain bronchodilators, after a risk assessment, for the acute relief of bronchospasm, e.g. salbutamol or the equivalent, with instructions left with the custody sergeant on other treatment if required. Any inhaler should be checked before being left with the detainee.

Custody staff may confuse hyperventilation for asthma in the custodial setting which may be feigned to attempt diversion. The HCP should perform a detailed assessment regarding management to exclude other causes such as infection, head injury, diabetic ketoacidosis, and other lung diseases. If the detainee is very anxious and has a panic attack, this would suggest the need for a further mental state assessment to exclude a psychiatric condition. Often reassurance is all that is required to calm the detained person and efforts should be made to slow the breathing.

Illustrative Case *A 35 year old female was arrested for theft from a shop. The police risk assessment stated that she had a 'blood clot—lung and right leg' and was on regular meds. The patient told the HCP that she had been diagnosed with a pulmonary embolus (PE) in the local hospital three weeks ago. She was supposed to be taking warfarin but was unaware of the dose and last took it 5 days prior to this assessment. Her last blood check for warfarin was 2 weeks ago. She had been asthmatic since childhood and used both salbutamol and steroid inhalers. Over the past year she had been admitted to hospital for pneumonia and severe asthma.*

Physical examination revealed that she was alert and cooperative. Her respiratory rate was 20 per minute and there was an audible wheeze. Her pulse rate was 103 beats per minute, BP 117/78, temperature 37.8, O2 91% on air. There was a pleural rub to the back of the right side of the chest and wheezes throughout the chest. The right calf was swollen and tender.

The HCP concluded that the female was not fit to be detained and referred her to hospital for treatment for suspected deep vein thrombosis, PE and an acute exacerbation of her asthma.

Diabetes

It is desirable to obtain a baseline blood glucose measurement (using a blood glucose meter) when diabetic detainees are initially assessed and for this to be repeated, if necessary, throughout the period of detention, especially for insulin dependent diabetics. There should also be access to either urine strips or specific meters to determine ketones in the event of detainees having an elevated blood glucose.

Consideration should be given to reducing the normal insulin dose as the carbohydrate load of many custody meals is relatively poor and it may be more appropriate to dose insulin post-food rather than pre-food in the custody setting due to risk of food refusal and subsequent hypoglycaemia. It may also be safer to allow the blood glucose to run a little higher than usual in this setting as risks associated with hyperglycaemia are long term rather than short term.

Insulin pump therapy also known as Continuous Subcutaneous Insulin Infusion is used in the treatment of insulin dependent diabetes. These infusion pumps can pose a particular difficulty in custody. The HCP should always assess the detainee and consideration given to appropriate levels of supervision, based on the overall risk assessment (likely to be constant supervision) [41].

Oral hypoglycemics and insulin should be continued and consideration given to supervision of insulin injections. Regular meals and snacks should be provided, and all diabetic patients should have access to rapidly absorbed carbohydrate-rich food. HCPs should also be alert to the potential for illicit substances to have been substituted for insulin in devices.

Hypoglycemia is easily treated [42]. If the blood glucose is less than 4 mmol/L in a conscious person, oral carbohydrate should be given, this may include usage of glucose gels or tablets. In an unconscious or restless detainee, an intravenous bolus of 20% dextrose solution may be given, however this is often not practical in the custody setting; therefore, glucagon can be given intramuscularly followed by 40% glucose gel orally or applied to the inside of the mouth. Glucagon can give an initial glycemic response even in a patient with alcoholic liver disease [43]; however, it should be remembered that in severe alcoholics with depleted glycogen stores, the response to glucagon may be reduced or ineffective.

Heart Disease

The main problems encountered include a history of hypertension, angina, cardiac failure, and stable dysrhythmias. Basic cardiovascular assessment may be required including examination of the pulse and blood pressure together with auscultation of the heart and lungs for evidence of murmurs or cardiac failure. Prescribed medication should be continued, and detainees should be allowed access to glyceryl trinitrate (GTN) spray. Chest pain that does not settle with GTN will require further assessment in the hospital [44].

Where patients are suspected of having an Acute Coronary Syndrome (ACS) HCPs should manage appropriately with aspirin 300 mg crushed or chewed as soon as possible, sublingual GTN spray, and oxygen, if saturations are less than 94% on air. It should be possible to provide these interventions in most custody settings whilst awaiting transfer to hospital [45].

Hypertension

This is often a concern, however HCPs should recognise that in the majority of cases the absolute value of blood pressure is not a primary concern, rather, it is the trend in values that matters.

Many detainees will have elevated blood pressure secondary to either exertion or anxieties relating to their situation. In the first instance, in an asymptomatic patient, the clinician should consider repeating the blood pressure manually.

HCPs should, however be alert to more concerning signs and symptoms which may indicate a need for further assessment. These include [46]:

- Accelerated hypertension (BP higher than 180/110 mmHg) with:
  - Papilledema
  - And/or retinal haemorrhage
- Suspected pheochromocytoma (labile or postural hypotension, headache, palpitations, pallor and diaphoresis)
- Rapidly increasing blood pressure

In the majority of cases, however, for detainees who are noted to have elevated blood pressure with no concerning sequelae they can simply be advised to arrange follow up with their own GP.

Sickle Cell Disease

Most detainees with sickle cell disease are aware of their illness and the symptoms to expect during an acute sickle cell crisis. Medical management in custody should not pose a problem unless there is an acute crisis, when hospital transfer may be required. Factors which may precipitate a crisis include:

- cold and rapid cooling after exercise e.g. following pursuit at arrest
- stress
- infection
- lack of analgesia
- dehydration

Conditions of detention should be suitable, with adequate heating and access to fluids and analgesics as appropriate.

General Injuries

Detailed documentation of injuries is an important and common request. The injuries may have occurred prior to or during the arrest, and documentation of such injuries may form part of the investigation to refute counter allegations of assault.

A record of each injury as outlined in Chap. 4 should be made and basic first aid provided. Certain wounds may be treated with Steristrips or glue/skin adhesive in the police station, [47] although transfer to a hospital may be required for further assessment, e.g. wound toilet, suturing, X-rays.

Head Injuries

Any suspected head injury should receive a detailed assessment [48]. The time, location, and nature of the injury should be ascertained from the detainee or from any witnesses who were present. The duration of any loss of consciousness and the behaviour since the injury should be noted.

Examination should include measurement of pulse and blood pressure, Glasgow Coma Scale [49] (Appendix 1), and neurologic assessment. The indications for hospital assessment include situations in which there are problems with the assessment of the patient or an increased risk of skull fracture or an intracranial bleed [50] and are illustrated in Fig. 9.1.

Ingestion of alcohol or drugs and relevant medical history should be ascertained. Although deaths in police custody are rare, head injuries accounted for 10% and substance abuse, including alcohol and drugs, accounted for 25% in a survey of such deaths between 1990 and 1997 in England and Wales [51]. These figures appear to be rising with 49% of deaths being in police custody in England and Wales related to substance misuse between 2004 and 2014 [52].

There should be a low threshold for referral to hospital, especially if a detainee with a head injury is also under the influence of alcohol and/or drugs.

If the detainee is to remain in custody, then instructions regarding the management of head-injured detainees should be provided both verbally and in writing to

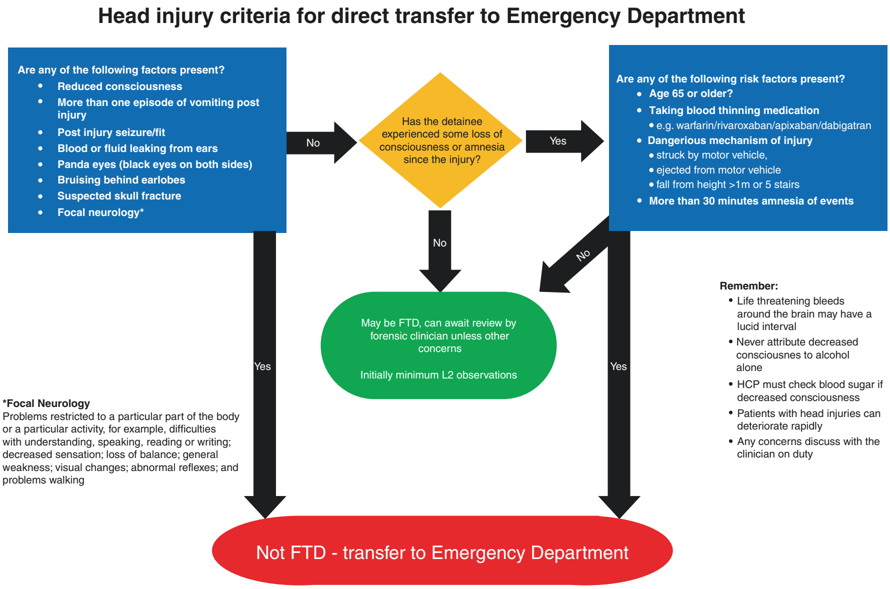

Fig. 9.1 Head injuries—Indications for hospital assessment

the custody staff and given to the detainee on release [53]. Police should be advised particularly that when checking a detainee's conscious level they are required to rouse and speak with the detainee, obtaining a sensible response (see Appendix 2).

Infectious Diseases

HCPs may be called to advise the police regarding infectious diseases. This subject is covered in Chap. 10. As the population in police custody could be seen as high risk for blood-borne viruses such as hepatitis and the human immunodeficiency virus [54] all detainees should be considered a potential risk, and observation of good clinical practice relating to body fluids, standard precautions, to avoid contamination is required.

Mental Health

General Psychiatric Problems

A significant proportion, around a third [8, 55] of detainees screened at custody will have some form of mental health condition. The police should be trained to recognize those detainees with mental health problems or intellectual disabilities (see Section "Intellectual Disabilities") at point of contact [5], but also on detention when carrying out a risk assessment [6]. When a psychiatric disorder is suspected, the custody staff should consider whether a HCP should be called to perform a full assessment, including mental state examination (Table 9.5) and mini-mental state examination (MMSE see Appendix 3) where appropriate to assess whether there is in fact any evidence of mental health problems.

Where a nurse or paramedic have concerns regarding the mental state of a detainee they should refer to the forensic physician for advice, or the criminal justice liaison& diversion service (CJLDS) who will then consider whether diversion from the criminal justice system is appropriate. If the detainee has committed a minor offense and there is only evidence of minor-to-moderate mental illness, treatment may be arranged in the community, in outpatients, or in the day hospital. If, however, the detainee is found to have an acute and severe mental illness, but has only committed a minor or moderate offense, then admission to the hospital for further assessment and treatment will be required either informally, or if necessary, formally. When the offense is more serious and there is evidence of probable mental illness needing further assessment, then the detainee may need to go before the court for such an assessment to be ordered.

Chronic stable mental health problems usually pose no specific problems for police detention, but may require specific safeguards when the detainee is to be interviewed by the police (see Chap. 11). Long-term medication should be continued.

Table 9.5 Mental State Examination [56]

Appearance	Self-care, clothing Motor e.g. restlessness, over activity, or retardation Level of consciousness
Behaviour	Disinhibition, withdrawn, aggressive, Attitude to examiner—hostile, cooperative friendly
Speech	Form and content of speech—talkative, pressure of speech, retardation, mute Presence of thought disorder, flight of ideas
Mood/affect	Objective and subjective Depression, anxiety, elation, hopelessness
Thoughts/perceptions	Hallucinations Delusions
Cognition	Orientation Concentration attention Memory—short and long term
Insight	Understanding and acceptance of situation
Other considerations: Biological symptoms	Sleep, appetite, energy levels
Self-harm and suicidal ideation	History of self-harm, type of self-harm, current thoughts, intention, protective factors, plans
Harm to others	Thoughts, intent, previous harm to others

Detainees with attention deficit hyperactivity disorder (ADHD) and attention deficit disorder (ADD) may not be easily recognized by custody staff and yet because of confrontational behaviour may come to the attention of the police. ADHD is associated with early offending and repeat offending into adult life [57]. Detainees with autism and Asperger's syndrome, part of the autistic spectrum disorders (ASD), and other developmental conditions, may have difficulties in social situations and with communication in custody environment.

Substance Misuse and Mental Illness

Concurrent substance misuse and mental illness—"dual diagnosis" or "co-morbidity"—is an important consideration. Dual diagnosis refers to people with a severe mental illness (including schizophrenia, schizotypal and delusional disorders, bipolar affective disorder and severe depressive episodes with or without psychotic episodes) combined with misuse of substances (the use of legal or illicit drugs, including alcohol and medicine, in a way that causes mental or physical damage).

In the Epidemiologic Catchment Area (ECA) study, 29% of individuals with a lifetime history of any mental disorder (other than substance use) had a history of substance use (22% alcohol disorder and 15% a drug disorder) [58]. In a study [59] of patients accessing community mental health teams and substance misuse services in urban UK centres, 44% reported past-year problem drug use and/or harmful alcohol use; 75% of drug service and 85% of alcohol service patients had a past-year psychiatric disorder. More recent studies have estimated prevalence rates of 20–37% in secondary mental health services and 6–15% in substance misuse settings in the UK [60]. Lifetime comorbidity in 1208 psychiatric patients diagnosed with schizophrenia in three European countries have also revealed prevalence rates of 19% in France, 21% in Germany, 35% in the United Kingdom [61].

There are a numbers of pathways to comorbidity [62]. There are those with a primary diagnosis of a major mental illness who have a secondary diagnosis of substance misuse that further affects their mental health. Such individuals may use drugs to relieve the adverse symptoms of their mental illness. Conversely, substance misuse may be the primary diagnosis leading to psychiatric complications and mental illness—for example, depression with suicidal ideation may occur amongst substance misusers. On occasions, mental illness and substance misuse may coexist together, such as when an underlying traumatic experience results in both substance misuse and posttraumatic stress disorder.

Self-Harm

Research has shown that episodes of self-harm typically occur soon after arrest. Particular risk factors include a previous history of self-harming and a past psychiatric history [63, 64]. Medical assessments should be requested for those detainees who give a clear intention of self-harming with attention given to any visible evidence of previous acts of self-harm.

If a detainee does self-harm, an assessment by a HCP should be carried out irrespective of whether there has been any physical injury, and an attempt should be made to assess the risk of suicide [65]. When the risk is thought to be high, then referral to a hospital will be required and the detainee should be kept under constant supervision until such transfer is arranged. When the risk is deemed to be low, clear instructions will need to be given to the custody officers regarding care and supervision. The custody officers may consider removal of the detainee's clothing and personal effects to prevent self-harm. Cells should be checked with respect to their structural integrity to prevent any defects being used to self-harm, and bedding should be of an appropriate standard.

It is important to explore the intent behind the episode of self-harm and ascertain if it is as punishment, release, or simply to feel something. It should not be assumed that an episode of self-harm in the custody setting is simply manipulative behaviour or 'acting out'. Liaison between agencies is essential, and when the detainee is transferred to prison, another police station, or hospital, details regarding the self-harming incident should be passed to the custody or hospital staff concerned so they can take appropriate precautions.

Detainees may arrive in custody having had suicidal ideation or attempts at self-harm and there should be a low threshold for a HCP assessment to asses the risk of further self-harm. Factors associated with an act of self-harm that indicate a high risk for suicide include:

- a medically serious act of SH; the writing of a suicide note;
- precautions having been taken against being found;
- stated wish to die;
- belief that the act would have proved fatal;
- expressed regret that the act failed;
- previous episode of DSH;
- depression and psychoses;
- substance misuse;
- co-morbidity;
- impulsive and aggressive personality traits;
- loneliness and lack of a social network

Pre-release Risk Assessment

In recent years in the UK HCPs are increasingly asked to conduct a pre-release risk assessment on a detainee where the police have concerns about the mental state of the detainee. This has resulted from an apparent rise in the number of suicides following police conduct [66].

In performing a pre-release risk assessment it is essential that the HCP understands that risk can be assessed and managed but varies over time and with the individual's particular circumstances. The most recent figures of deaths following police contact in England and Wales show that the commonest cause for arrest was for sexual offences [66]. Interventions can decrease or increase risk and assessment requires information from many sources, involving colleagues whenever possible. A clear management plan should aim to reduce risk and reduce the personal distress of the individual. As with all assessments in clinical forensic medicine the plan should be recorded in detail and should be shared with colleagues. The presence in custody of criminal justice liaison and diversion staff can assist with information regarding an individual patient and help with the organisation of appropriate services, treatment, and follow-up.

Intellectual and Developmental Disabilities (IDDs)

Intellectual disability (ID) is a term used when there are limits to a person's ability to learn at an expected level and function in daily life. ID starts any time before a child turns 18 and is characterized by problems with both intellectual functioning or intelligence, which include the ability to learn, reason, problem solve, and other skills; and adaptive behaviour, which includes everyday social and life skills [67]. ID maybe mild, moderate, severe, or profound, although the focus is more on daily skills rather than a measure of IQ.

Developmental disabilities are a broader category of often lifelong disabilities that can be intellectual, physical, or both. Differing parts of the body may be affected, e.g. the nervous system (cerebral palsy, Down's syndrome, autism spectrum disorders); sensory system ((affecting sight, hearing, touch, taste, and smell) preterm infants, ASD); metabolism (phenylketonuria, congenital hypothyroidism); and degenerative [68].

Intellectual and Developmental Disabilities (IDDs) is used to describe situations in which intellectual disability and other disabilities are present.

Tourette's Syndrome (TS) is a condition of nervous system that causes people to have tics, sudden twitches, movements, or sounds that people do repeatedly. There are two types: motor with movements of the body; or vocal resulting in sounds that a person makes with his or her voice. Furthermore the tics can be simple or complex [69].

It is important to identify detainees with IDDs, so precautions can be put in place to protect them while detained in police custody (see also Chap. 11). Although there is no easy way to recognize individuals with such disabilities, questions [70] regarding employment, schooling, reading, writing and telling the time, contact with relevant services/agencies, as well as enquiries as to whether they live independently may assist in identifying this vulnerable group. Intellectual disabilities should not be confused with learning disorders including dyslexia, dyscalculia and dysgraphia.

Illustrative Case *A male detainee, aged 18 years, had been arrested on suspicion of common assault. The police had performed a risk assessment and established that there was a history of Tourette's, ADHD, OCD, and anxiety. The HCP was called to assess fitness to be detained and interviewed. The detainee confirmed the mental health conditions as given in the risk assessment. He said he was under the care of the local community mental health team and had been admitted to psychiatric hospitals on a number of previous occasions, including an involuntary admission. He was not taking any medication. He described a number of different placements with regard to education including being home schooled and was currently unemployed. Examination revealed the he was restless, anxious and at times aggressive. His mood was volatile and unpredictable. There was evidence of involuntary sounds and tics during the consultation. He was alert and orientated in time, place and person with normal speech content and there was no other abnormality on the mental state examination. He was aware of the reason for his arrest and he had previously been detained in a police station. The HCP concluded that the detainee was fit to be detained and interviewed but in view of the history of mental health conditions and IDD he would require the presence of an AA.*

Claustrophobia

Claustrophobia is a common complaint, and a detailed history and examination with an emphasis on the presence or absence of anxiety when faced with the problem in everyday life should be sought. An enquiry regarding behaviour at home, such as leaving doors and windows open, avoidance of elevators and underground trains, and a history of the original precipitant for such behaviour should be noted.

Where there is significant anxiety it may be appropriate to allow the detainee to use an open space if available within the custody complex, or, there may be the option for an observation cell which has a clear perspex door.

Often reassurance is enough, and it is rarely necessary to give any medication. The custody staff should be advised if genuine claustrophobia is suspected as this may affect the detainee's fitness to be interviewed.

Pregnancy

It is not uncommon to have pregnant detainees in police custody or detainees who state that they are pregnant. Access to on-site pregnancy testing kits is an advantage. Irregular menses are common in substance misusers, especially those dependent on opiates [71]. HCPs will need to assess each case and decide whether to recommend detention or transfer for obstetric assessment. Extreme caution is required in prescribing medication, especially opioid substitute prescribing [56].

It is useful to take a detailed history of the pregnancy, the last menstrual period, estimated date of delivery, previous pregnancies, and outcomes. Specific enquiry should be made about the presence of fetal movements, abdominal pain, or bleeding per vagina. Occasionally, pregnant detainees may not have had any contact with local services such as antenatal, and drug services if required, and this consultation is an opportunity for intervention. There should be a low threshold for referral to hospital. Before the 8th month of pregnancy, asymptomatic detainees can usually be considered fit for detention during the daytime, depending on material conditions in police cells [72].

Detainees Who Refuse Nourishment

The HCP may have to advise custody staff regarding a detainee's diet. If a detainee refuses food for 24 h, the HCP should be called to assess the detainee as to the capacity to make such a decision and should explain to the detainee the consequences of food refusal. If the detainee has refused fluids, then they should be seen more regularly as the physical and mental state of the detainee may deteriorate quickly. A general physical examination should be performed including body weight, body mass index, blood pressure, and pulse.

It is important to differentiate between food refusal and a hunger strike; the latter refers to a means of protesting by fasting, generally associated with a demand of some kind [73]. Food refusers do not wish to cause themselves harm whereas the hunger striker has a specific motivation. The initial mental state examination, and assessment of capacity, is therefore crucially important. If there is a history of mental illness, or evidence of undiagnosed conditions, then a referral for an expert psychiatric opinion should be made. A fast of 72 h is considered the beginning of a hunger strike.

Table 9.6 ABCDE assessment based on ABCDE approach guidelines by Resuscitation Council UK [45]

Airway	Patency, ability to maintain
Breathing	Efficacy & effort of breathing
Circulation	Peripheral and central perfusion, pulse rate, skin colour and temperature, capillary refill, blood pressure etc.
Disability	Neurological function, moving all four limbs, pupils & blood glucose
Exposure	Rashes, temperature, injuries

Detainees Who Refuse Assessment

When a detainee declines or refuses assessment the HCPs have a responsibility to ensure that they have made some form of assessment/observation of the detainee. It is essential that the HCP visits the detainee and offers an assessment making an attempt to engage with the detainee. If the detainee refuses to be seen this should be noted along with a record of observations made.

A detainee who shouts at the HCP has demonstrated that they have a patent airway, is breathing sufficiently to vocalise and shout, and is perfusing the brain sufficiently to ascertain that they are arguing with a HCP not a police officer. This allows the HCP to complete at least four stages of an ABCDE [45] assessment (see Table 9.6). If the detainee is walking around in the cell naked or partially clothed the HCP may be able to complete the majority their E assessment too.

HCPs should be alert to the possibility that erratic or aggressive behaviour may be due to an undiagnosed head injury/low blood glucose/alcohol or drug (particularly stimulant) intoxication rather than simply ascribing it to the detainee's attitude.

An entry should be made on the custody record that the detainee refused assessment but was observed in the cell with a summary of the findings and a note completed in the clinical record.

Personal Safety Issues

Certain healthcare groups are at increased risk of violence in the workplace, for example, those working in the custodial environment [74] or accident and emergency services [75]. Accurate assessment regarding the possibility of violence will reduce the danger, but it should never be assumed that there is no risk, and every clinical situation should be categorized as high risk due to an obvious risk or unknown/standard risk due to undiscovered factors [76]. There are a number of strategies for interviewing a difficult detainee [77], which include being fully aware of previous history and warning markers (be prepared!), and considering how they see you (as uninterested or hostile?), being polite and respectful, avoiding confrontation, using appropriate eye contact, keeping calm, and showing interest. Look for signs of tension and find out why tension may be increasing. Finally, be ready to

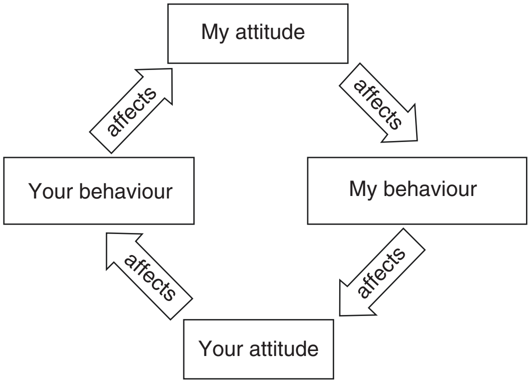

Fig. 9.2 Betari Box

leave if necessary and consider the need to have a chaperone (appropriately trained in restraint techniques) of the same sex as the patient to be examined.

Clinicians should also be alert to the way that their actions may impact on interactions and consider the Betari Box model in Fig. 9.2.

This highlights the importance of planning workloads/rotas appropriately and ensuring healthcare professionals are appropriately rested prior to a shift.

Drug Searches

Persons unlawfully in possession of illicit drugs for personal use or involved in drug supply or trafficking may ingest drugs or pack them into certain body cavities. Terminology is important [56, 78].

Body stuffers (also known as swallowers/contact precipitated concealers) is a term commonly used to describe people who swallow illicit drugs to avoid being found with the drugs in their possession by (police) authorities. Body pushers are those who insert drugs into either their vagina or rectum, to avoid being found in possession of drugs.

Body packers (‘drug couriers’ or ‘surgical mules’) is the term commonly used to describe people who swallow packets of illicit drugs or put them into body orifices (using condoms or other containers, often purposely designed to escape detection) as they pass through customs checks. Third parties may be employed to act as mules and a case of body packing using children, two boys aged 6 and 12, who had concealed heroin has been reported [79].

Detainees who have recently swallowed drugs should be taken immediately to an emergency department for full assessment [5] and treated as any other overdose of these substances [80].

Doctors and nurses may be called by the police to carry out intimate searches of those arrested (see Chap. 2) [81]. Any healthcare professional who agrees to perform an intimate search should have the required skills and a comprehensive understanding of the risks involved and their management. This includes understanding the limitations of such intimate searches such as recognition that proctoscopy cannot exclude rectally inserted packages due to potential retrograde peristalsis and the length of a proctoscope. The limitations of such intimate searches would usually suggest that even a negative examination would mandate a period of observation for several hours. There is no evidence that the passage of a number of normal stools confirms that there are no other drug packages within the individual's body [66]. Low dose CT scanning may be a safer alternative to search for packages.

The HCP should discuss the possible implications of the ingestion of certain drugs and obtain fully informed consent from the detainee before carrying out any search that may involve examination of the mouth, nostrils, ears, umbilicus, foreskin, rectum, or vagina [82] or request radiological examination.

Variable quantities of drugs such as heroin, cocaine, cannabis, and amphetamine may be packaged in layers of cellophane or in condoms. All searches for such drugs should be carried out in premises where there are full facilities for resuscitation [83] in case significant quantities of the drugs leak into the bloodstream, resulting in acute intoxication and death from overdose [84, 85]. Other medical problems such as bowel obstruction may also occur.

The aim of medical management is to prevent these complications, but for ethical reasons the retrieval of packages for legal purposes alone is no indication for intervention without the detainee's permission. Therefore, without such permission, the HCP can do nothing except advise the police authorities that the detainee should be observed. In most asymptomatic patients, a trial of conservative treatment, provided bowel obstruction or package perforation is not suspected, will result in the uncomplicated elimination of all ingested packages [86, 87].

In a genuine emergency, when there is no possibility of obtaining consent, the clinician has a duty to carry out treatment to safeguard the life and health of a patient in accordance with what would be accepted as appropriate treatment in the detainee's best interests [88]. In these cases it may be appropriate to remove the packages in order to reduce future absorption. However, body stuffers can develop symptoms hours after ingestion with delayed toxicity leading to death. A fatal case report of a cocaine body stuffer concluded that the integrity of the packaging has an important predictive value in determining the time and likelihood of toxicity [89]. A nonfatal case of significantly delayed toxicity has also been reported [90].

Forensic Samples

Samples from a detainee such as dental impressions, blood, urine, hair, fingernail swabbing and cuttings, and swabs (e.g. mouth, penile, vaginal) may be requested by police authorities in connection with the investigation of an offense. These samples should only be taken by an appropriately trained HCP for evidential purposes with the detainee's fully informed consent and should be packaged in accordance with local procedures to ensure the chain of evidence. For further details regarding samples see Chap. 3.

Restraint (See Chap. 7)

Within the custody suite it is not uncommon for detainees to require some degree of restraint. Whilst in the majority of cases this is relatively minimal, in some cases it may be a much more significant intervention.

Role of the HCP in a Significant Restraint Episode

Although the custody sergeant is ultimately responsible for the welfare of the detainee the HCP has an important role to play. This can be divided into three parts:

Prior to Intervention

If there is a planned intervention (e.g. cell removal/transfer) rather than an acute reactive intervention the HCP should take time to review the risk assessment as well as any previous medical assessments to advise the officers of any specific risks due to the detainee from a known medical condition. It may be relevant for the HCP to be involved in initial de-escalation with the detainee as the response may be better to the HCP's input rather than to police intervention.

During the Restraint

When the HCP becomes aware of a restraint episode they should attend immediately if possible to observe the restraint. Guidance from the Independent Advisory Panel on Deaths in Custody requires there to be a member of staff (controller) in charge of restraint whenever three or more officers are involved in a restraint episode [91]. Usually this will be the police officer responsible for protecting the detainees head, neck and airway.

The HCP should not take part in restraining the detainee, rather they should observe the restraint throughout and monitor the detainee's condition. During the restraint particular attention should be paid to any potential compromise of the airway, breathing or circulation and the HCP should be alert to any deterioration in the detainee's clinical condition. The risk of acute behavioural disturbance/excited delirium should be considered. If the HCP observes restraint techniques that have the possibility to impair the detainee's airway, or ability to breath, they must alert the restraint team.

Post Restraint

The clinician should document on the custody record that they were present throughout the restraint and (provided it is the case) that they observed the detainee throughout and at no time was their airway or breathing compromised. They should complete a full clinical assessment of the detainee (which may include documentation of any injuries sustained) as soon as practicable after the restraint episode. If irritant spray has been used the HCP may wish to refer to FFLM guidance [92] on irritant sprays (also see Chap. 6).

Terrorist Detainees

HCPs may be asked to assess those detained under terrorism legislation. Such an assessment should be carried out by an experienced forensic physician who will outline a management plan for the multidisciplinary team [93]. The same general principles apply as for any other detainee but in England and Wales there are separates Codes Of Practice under PACE Code H [94]. It should be remembered that terrorist detainees may be held for longer periods of time and in solitary confinement. Solitary confinement is defined by the Istanbul statement as the physical isolation of individuals who are confined to their cells for 22–24 h a day [95]. It is essential that a high standard of care and ethical behaviour is maintained by clinicians, including providing advice on the physical conditions and overall regime [96].

Key Points

- Although the custody environment can be challenging, care provided should be equivalent to that provided in non-custodial settings.
- The population managed in custody may have the same range of illnesses or injuries seen in other settings, however there is an increased incidence of mental health and substance misuse issues which can complicate care.

Self-Assessment Exercises

1. How might the medication regime of an insulin dependent diabetic need to be amended in the custody setting?
2. List the factors associated with an act of self-harm that may indicate a high risk for suicide.
3. Thinking about where you currently practice, what methods might be available for you to confirm a detainee’s prescribed medication?
4. In what circumstances might a detainee be unfit to be detained but not need transfer to hospital or an alternative healthcare setting?

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Appendix 1: Glasgow Coma Scale

Behaviour	Response	Score
Eye opening response	Spontaneous	4
	To speech	3
	To painful stimulus	2
	None	1

Behaviour	Response	Score
Best verbal response	Orientated	5
	Confused	4
	Inappropriate words	3
	Incomprehensible sounds	2
	None	1
Best motor response	Obeys commands	6
	Localises to painful stimulus	5
	Withdraws from pain	4
	Abnormal flexion (decorticate)	3
	Abnormal extension (decerebrate)	2
	None	1

From Jennett and Teasdale [49]

Appendix 2: Detained Person: Observation List

1. If any detainee fails to meet any of the following criteria, an appropriate healthcare professional or ambulance must be called
2. When assessing the level of rousability consider:
Rousability—can they be woken?
• Go into the cell
• Call their name
• Shake gently
Response to questions—can they give appropriate answers to questions such as:
• What's your name?
• Where do you live?
• Where do you think you are?
Response to commands—can they respond appropriately to commands such as:
• Open your eyes!
• Lift one arm, now the other arm!
Remember—take into account the possibility or presence of other illnesses, injury, or mental condition, a person who is drowsy and smells of alcohol may also have the following:
• Diabetes
• Epilepsy
• Head injury
• Drug intoxication or overdose
• Stroke

From: Home Office. Code C. Annex H [16]

Appendix 3: The Mini-Mental State Examination

Task	Score
Orientation	
What is the (year) (season) (date) (day) (month)	__/5
Where are we: (country) (state) (county) (town) (police station)	__/5

Registration	
Examiner names three objects (e.g., orange, key, ball)	
Patient asked to repeat the three names	
Score one for each correct answer	__/3
Then ask the patient to repeat all three names three times	
Attention	
Serial 7's. Stop after 5 correct answers	
Alternatively, if patient makes errors on serial subtraction: Spell	
"World" backwards: D L R O W	
Score best performance on either task	__/5
Recall	
Ask for the names of the objects learnt earlier	__/3
Language	
Show and ask the patient to name a pencil and a watch	__/2
Repeat the phrase "No ifs, and, or buts"	__/1
Give a three-stage command. Score one for each stage (e.g., "Take this piece of paper in your right hand, fold it in half, and place it on the chair next to you")	__/3
Ask patient to read and obey a written command on a piece of paper stating: "Close your eyes"	__/1
Ask the patient to write a sentence. Score correct if it has a subject and a verb	__/1
Copying	
Ask patient to copy intersecting pentagons. Score as correct if they overlap and if each has five sides	__/1
Total score	**__/30**

From Folstein et al. [97]

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Infectious Diseases: The Role of the Healthcare Professional

10

Felicity Nicholson

Learning Objectives

Explanation of the importance of taking standard precautions with all patients.

Treatment of an 'at risk exposure' and organization of a management plan.

Demonstrate the ability to provide advice to the police with regard to the effective management of the common infectious diseases seen in custody.

Introduction

Infections have plagued healthcare professionals (HCPs) for centuries, both in the diagnosis of the specific diseases, and the identification and subsequent management of the causative agents. There is a constant need for information as new organisms emerge, existing ones develop resistance to current drugs or vaccines, and there are changes in epidemiology and prevalence. In the twenty-first century, obtaining this information has never been more important. Population migration, and the relatively low cost of flying, means that unfamiliar infectious diseases may be brought into industrialized countries. An example of this was an outbreak of severe acute respiratory syndrome (SARS), which was first recognized in 2003. Despite modern technology and a huge input of money, it took months for the agent to be identified, a diagnostic test to be produced, and a strategy for disease reporting and isolation to be established.

A further example of how population migration can result in the spreading of disease was with the appearance of swine influenza A (H1N1). In March 2009, the first case was reported in Mexico; by June 2009, over 22,000 cases had been reported in 70 countries, thus fulfilling the criteria for a pandemic. Challenges ensued with decisions about treatment and then the distribution and administration of specific vaccine. More recent examples include the discovery of Corona virus Mers CoV

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which emerged predominantly from the Middle East in 2012 and spread to many countries. In 2014 there was an Ebola outbreak in West Africa which lead to cases being transferred to Europe and the USA.

There is no doubt that other new and fascinating diseases will continue to emerge. For the healthcare professional dealing with infections presents two main problems. First, managing detainees or police personnel who have contracted a disease and may be infectious or unwell, and second, handling complainants of assault, including police officers, who have potentially been exposed to an infectious disease. The latter can be distressing for those involved, compounded in part from an inconsistency of management guidelines, if indeed they exist.

With the advent of human rights legislation, increasing pressure is being placed on HCPs with regard to consent and confidentiality of the detainee. Therefore, it is prudent to pre-empt such situations before the consultation begins by obtaining either written or verbal consent from the detainee to allow certain pieces of information to be disclosed. If he/she does not agree, then the HCP must decide whether withholding relevant details will endanger the lives or health of those working within custody or others with whom they may have had close contact (whether or not deliberate). Issues of consent and confidentiality are discussed in detail in Chap. 2.

Adopting standard precautions with all detainees will decrease the risk to staff of acquiring such diseases and will help to stop unnecessary overreaction and unjustified disclosure of sensitive information. For victims of violent or sexual assault, a more open-minded approach is needed (see also Chap. 3). If the assailant/suspect is known, then it may be possible to make an informed assessment of the risk of certain diseases by ascertaining their lifestyle and where possible by asking permission to test for certain diseases. If, however, the assailant is unknown, then this is not possible and so it is best to assume they are infected. This chapter aims to highlight the most common infections encountered by the healthcare professional. It aims to dispel "urban myths" and provide a sensible approach for achieving effective management.

Standard Precautions

The risk of exposure to infections, in particular to blood-borne viruses (BBVs), can be minimized by adopting measures that are considered good practice in the UK, the USA and Australia [1–3]. The Guidance for Clinical Health Care Workers: Protection against infection with blood borne viruses, (DOH 1998) contains standard precautions. The aim of adopting standard precautions is to prevent transmission of BBVs by considering that blood and other body fluids are potentially infectious. It means never assuming that there is no risk. If every patient is assumed to be potentially infected with a blood borne infection the same precautions to prevent exposure should be used for every procedure.

Healthcare professionals should wash their hands before and after contact with each detainee or victim. A laminated copy of good hand washing techniques (e.g. from the National Patient Safety Agency) should be displayed by the sink in the medical room. Liquid soap from a wall mounted dispenser should be used routinely. Alcohol hand rub can be used as an alternative if hands are dry and physically clean. It should not be used if the patient has had diarrhea in the last 48 h as it is not effective against Norovirus or Clostridium difficile. Police officers should be encouraged to wash their hands after exposure to body fluids or excreta. All staff should wear gloves when exposure to body fluids, mucous membranes or non-intact skin is likely. Gloves should also be worn when cleaning up body fluids or handling clinical waste including contaminated laundry. Only single-use gloves which are powder free should be used and must conform to the requirements of British and EN standards and be CE marked or equivalent [1–3]. A synthetic alternative conforming to the same standards should also be available for those allergic to latex e.g. nitrile.

All staff should cover any fresh wounds (less than 24 h old), open skin lesions or breaks in exposed skin with a waterproof dressing. Single gloves have been shown to remove 86% of surface blood and therefore reduces the risk of acquiring a BBV infection. Doubling gloving removes even more. Gloves should be worn when taking blood, providing this does not reduce manual dexterity and therefore increase the risk of accidental percutaneous injury.

A designated person should be allocated to ensure the clinical room is kept clean and sharps containers and clinical waste bags should be removed on a regular basis. Clinical waste must be disposed of in "hazard bags" and should never be over-filled. After use they should be double-bagged and sealed with "hazard tape". The bags should be placed in a locked designated waste disposal store and removed by a professional company. When cells are contaminated with body fluids, a professional cleaning company should be called to attend as soon as possible. Until such time, the cell should be deemed "out of action".

Ideally there should be a designated infection control lead who has the overall responsibility of auditing the premises and ensuring that they meet infection control standards.

Sharps Awareness

The main risk of sharps injury is the potential acquisition of the major blood borne viruses (BBV) hepatitis B, hepatitis C, and HIV. Other infectious agents can also be transmitted through sharp injuries including but not limited to Human T Lymphotrophic retroviruses (HTLVI & II), Cytomegalovirus, and Epstein Barr virus.

Whether or not an infection is acquired depends on a number of factors including the person's immune system, the type of sharp involved, the depth and site of the sharp injury and how infectious the blood was at the time of the injury.

Whilst the number of sharp injuries leading to infection is small, there are the direct costs of the medication to consider alongside the psychological impact which is harder to quantify. There may also be side effects from the medication and time lost from work.

There is a legal requirement in the UK under the Environmental Protection Act (1990) and the Control of Substances Hazardous to Health Regulations 2002 (COSHH) to dispose of sharps in an approved container. In the USA, the Division of Healthcare Quality Promotion (DHQP) on the Centers for Disease Control and Prevention (CDC) website provides similar guidance. Further guidance can also be find in the ‘Stop Sticks’ campaign run by the National Institute for Occupational Safety and Health (NIOSH).

In custody where sharps containers are transported off site, they must be of an approved type and the correct UN approved color. In the UK, such a requirement is contained within the Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 2009. These measures help to minimize the risk of accidental injury. Further precautions include wearing gloves when handling sharps and never bending, breaking or re-sheathing needles before disposal. Sharps bins should never be more than three quarters full, they should be secured to the wall when in use and should be placed at a safe height for those using it to minimize the risk of inoculation injuries when disposing of the sharps.

Contaminated Bedding

Any bedding that is visibly stained with body fluids should be handled with gloves. There are only three acceptable ways of dealing with contaminated bedding:

1. Laundering with a detergent at a minimum temperature of 71 °C (160 °F) or at a lower temperature (22–50 °C) with water containing detergent and 50–150 ppm of chlorine bleach.
2. Dry cleaning at elevated temperatures/dry cleaning cold followed by steam pressing.
3. Incineration.

It is not considered acceptable practice to share bedding between detainees.

Other Measures

It is not necessary for staff to wear masks or protective eyewear in the custodial setting as the risk of infection is low. However, single use eyewash should be available in the clinical room or contained in other first aid kits located within the police station in case of accidental exposure. Contact lenses should be removed prior to eye washing.

Formulation of Guidelines

An example of good practice is contained within the UK Health Department’s 1998 document [1] which states “that it is the responsibility of Health Authorities, Health Boards and NHS Trusts to create their own local guidelines to prevent the spread of

BBVs in the health care setting". The Health and Social Care Act 2008 Code of Practice on the prevention and control of infections and related guidance also sets out the standards for the NHS and other regulated health care providers. Such guidelines may not exist in other work places. If this is the case, then they should be formulated as soon as possible. It is also prudent to pre-arrange a system of referral with the nearest hospital that has an Emergency Department, a Genito-Urinary Department and access to a Specialist. The latter may be a consultant in Virology, Microbiology, Infectious Diseases or Genito-Urinary Medicine. Similar guidance in the USA can be found in "The Guideline for Infection Control in Health Care Personnel" [4].

Most exposures to staff usually result from a failure to follow accepted practice; however, accidents can happen no matter how much care is taken. All healthcare professionals working in custody should understand what constitutes a risk and should have had relevant infection control training. This involves taking a detailed history of the incident, including the type of exposure, the body fluids involved and when it occurred.

This information could help to allay unnecessary anxiety from the outset and will ensure that the recipient of the exposure is referred, if appropriate, to the designated hospital at the earliest opportunity. Knowledge of precise treatment protocols is not required, but it is helpful to be able to explain to the recipient what to expect. For example, he or she will be asked to provide a voluntary baseline blood sample for storage and a number of follow-up samples for testing depending on the nature of the exposure. This is especially relevant for hepatitis B (HBV), hepatitis C (HCV) and human immunodeficiency virus (HIV). Most usually, this will be complete by 12 weeks, but on occasion testing may be extended to 6 months after the incident.

Sexual assault complainants should ideally be referred to specialist centers, if available. A police station should only be used as a last resort because the environment is often hostile and there is no ready access to the necessary treatment and ongoing management (see Chap. 3).

Routes of Transmission

Organisms may utilize more than one route. For ease of understanding, the infections discussed in this chapter are classified according to their primary route, i.e. transmission through blood and body fluids; through contact with lesions or organisms; through the respiratory route; and through the fecal-oral route.

Transmission Through Blood and Body Fluids

The BBVs which present most cross-infection hazard to staff or victims are those associated with persistent viral replication and viremia. These include hepatitis B (HBV), hepatitis C (HCV), hepatitis D (HDV), and human immunodeficiency virus (HIV).

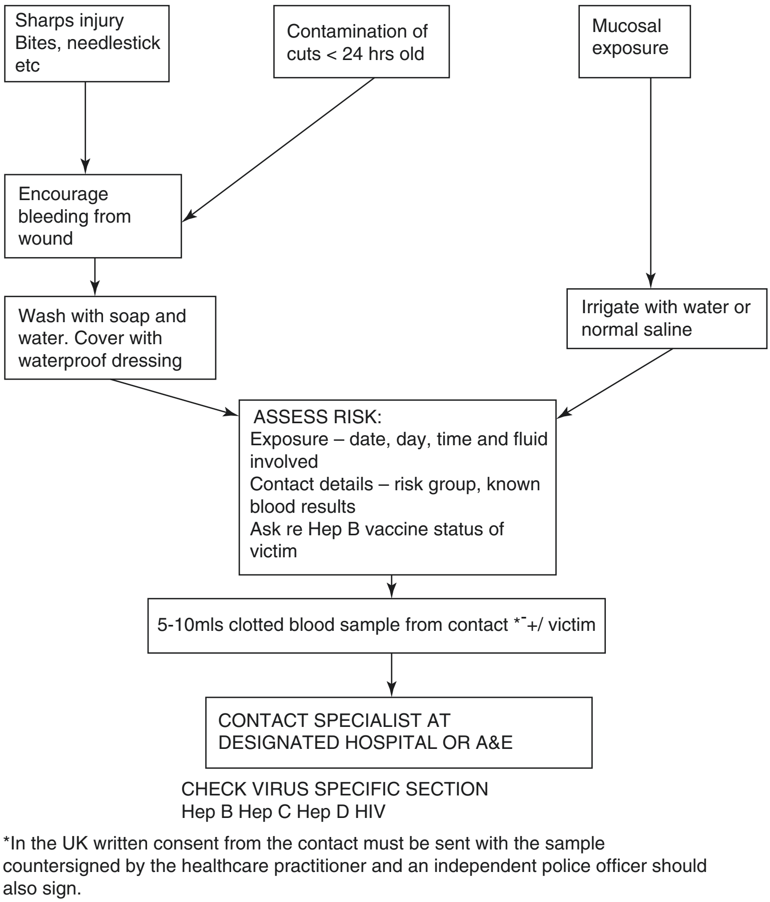

Fig. 10.1 Immediate management following occupational exposure to blood-borne viruses (BBVs)

In general, risks of transmission of BBVs arise from the possible exposure to blood or other body fluids. The degree of risk varies with the virus concerned and will be discussed under the relevant sections. Figure 10.1 illustrates the immediate management following a percutaneous injury, mucocutaneous exposure, or exposure through contamination of fresh cuts or breaks in the skin.

Hepatitis B

Epidemiology and Prevalence

HBV is endemic throughout the world with populations showing a varying degree of prevalence. Approximately 2000 million people have been infected with HBV. In

Table 10.1 Prevalence of chronic hepatitis B by world areas

Prevalence	Areas
Low <2%	Most of western Europe including the UK, North America, Australia (excluding the Aborigines), New Zealand
Intermediate (2–8%)	Mediterranean, the Amazon Basin, most of the Middle East, japan, the Indian Sub Continent and southern parts of Eastern and Central Europe
High >8%	Sub Saharan Africa, most of Asia and the Pacific Islands

2015 there were 257 million people living with chronic infection world-wide [5]; and world-wide in that same year HBV killed 887,000 people.

With the development of a safe and effective vaccine in 1982, the World Health Organization (WHO) recommended that HBV vaccine should be incorporated into national immunization programmes by 1995 in those countries with a chronic infection rate of 8% or higher and into all countries by 1997. In 2015 global coverage with the three doses of hepatitis B vaccine in infancy reached 84%. However coverage with the first birth dose of vaccine remains low at 39%. Meaning that some of the poorer countries were not meeting their targets [5].

In the United Kingdom, the overall prevalence of chronic HBV is around 0.1–0.5% [6] which according to the WHO classification based on the prevalence of HBsAg is low (less than 2%). Other low prevalence areas include most of Western Europe and North America. High prevalence which is found in sub Saharan Africa, most of Asia and the Pacific Islands has a prevalence of more than 8% (see Table 10.1).

Symptoms and Complications

The incubation period is approximately 40–160 days. As the name suggests, the virus primarily affects the liver. Many people with acute infection have a sub clinical or flu-like illness. Typical symptoms include malaise, anorexia, nausea, mild fever, and abdominal discomfort and may last from 2 days to 3 weeks before the insidious onset of jaundice. Joint pain and skin rashes may also occur due to immune complex formation. Infections in the newborn are usually asymptomatic.

The majority of patients with acute HBV make a full recovery and develop immunity. Following acute infection, about 1 in 300 patients develop liver failure, which may result in death.

Chronic infection develops in around 90% of neonates, about 20–50% of children infected between the ages of 1–5 years old and around 5% of adults. Neonates and children are usually asymptomatic. Adults may have only mild symptoms or may also be asymptomatic. Approximately 20–25% of chronically infected individuals (depending on age of acquisition) will develop cirrhosis over a number of years. This may also result in liver failure or other serious complications including hepatocellular carcinoma, though the latter is rare. The overall mortality rate of HBV is estimated at less than 5%.

Table 10.2 Significance of markers

Name	Infectivity	Immunity	Risk following needle stick (%)
HBsAg	Yes	No	Only marker = 10–20
HBeAg	Yes	No	With HBsAg = 30–40
HBeA	Yes	Yes	With HBsAg ≤ 10
HBCA	No	Yes	0
HBSA	No	Yes	0

HBsAg Hepatitis B surface antigen, *HbeAg* hepatitis B e antigen, *HBeA* hepatitis B e antibody, *HBCA* hepatitis B core antibody, *HBSA* hepatitis B surface antibody

Period of Infectivity

A person is deemed infectious if hepatitis B surface antigen (HBsAg) is detected in the blood. In the acute phase of the illness, this can be for as long as 6 months. By definition, if HBsAg persists for after this time then the person is deemed a carrier. Carriers are usually infectious for life. The degree of infectivity depends on the stage of disease and the markers present in Table 10.2.

Routes of Transmission

The major routes include: parenteral (e.g. needlestick injuries, bites (rare), blood transfusions (rare in the UK as blood donors and donations are screened), tattooing, acupuncture and dental procedures, where equipment is inadequately sterilised); mucous membrane exposure (including mouth, eyes and genital mucous membranes including vaginal and anal intercourse), through perinatal transmission from mother to child and contamination of broken skin (especially when <24 h old).

At-Risk Groups

HBV is an occupational hazard for anyone who may come into contact with blood or bloodstained body fluids through the routes described above. Saliva alone may transmit HBV. The saliva of some people infected with HBV has been shown to contain HBV-DNA concentrations 1/1000–1/10,000 of that found in their serum [7]. This is especially relevant for penetrating bite wounds. Infection following exposure to other body fluids, e.g. bile, urine, feces and CSF, has never been demonstrated unless the fluids are contaminated with blood.

In 2016 in England there were 453 reported cases of acute or probable acute cases of hepatitis B [8]. The prevalence of acute hepatitis B in London was 1.7/100,000 population compared with 0.82/100,000 nationally. Where a route of transmission was identified, in 64.6% cases the mode of transmission was through heterosexual exposure. Men who have sex with men accounted for 14% of the cases. However, only 36% had information about the associated exposure. None the less the data presented suggests that the number of cases of acute hepatitis B in PWID has remained low in 2016. Periodic surveys in PWID show that the hepatitis B prevalence is around 1 in 500 [9] This is thought to be in part due to increased awareness, and self-reported hepatitis B vaccine uptake. In 2016 about 75% of PWID reported having hepatitis B vaccine, but this level is no longer increasing. Uptake is especially low in younger age groups and amongst new injectors [8].

Evidence has shown that the virus may also be spread among members of a family through close household contact. This is thought to be through kissing, sharing toothbrushes, razors, bath towels, etc. [10–12]. This route of transmission probably applies to institutionalized patients.

In the Public Health England Health and Justice Annual Review 2017/2018 [13] the prevalence of blood-borne viruses was four times higher in the prison population than in the general population. Hepatitis B prevalence was reported as 0.6% in the prison population versus 0.16% in the general population.

HBV can be transmitted vertically from mother to baby during the perinatal period. Around 80% of babies born to mothers who have either acute or chronic HBV become infected and most will develop chronic HBV. This has been limited by the administration of HBV vaccine to the neonate. In industrialized countries all antenatal mothers are screened for HBV. Vaccine is given to the neonate ideally within the first 12 h of birth and at least two further doses are given at designated intervals. The WHO recommends this as a matter of course for all women in countries where prevalence is high. However, the practicalities of administering vaccine that has to be stored at the correct temperature and limited access to medical care mean that there is a significant failure of vaccine uptake and response.

Disease Prevention

In industrialized countries, HBV vaccination is recommended for those deemed at risk of acquiring the disease

1. Through occupational exposure
2. Homosexual/bisexual men
3. People who inject drugs
4. Female commercial sex workers
5. Patients with chronic renal or hepatitis disease
6. Sexual partners of people with acute or chronic HBV including victims of sexual assault
7. Family members of people with acute or chronic HBV
8. Newborn babies whose mothers are infected with HBV. If the mother is HBeAg positive, then HBV-specific immunoglobulin (HBSIG) should be given at the same time as the first dose of vaccine
9. If the baby is born to an HBV negative mother but is going home to another HBV positive household member they should receive one dose of Hepatitis B vaccine before leaving hospital and then continue on the routine schedule [10]
10. Institutionalized patients and inmates of custodial institutions.
11. As of October 2017, hepatitis B has been incorporated in a hexavalent vaccine which is given to all babies born in the UK with doses being at given at 2, 3 and 4 months

Ideally, HBV vaccine should be administered prior to exposure. For most adult and child risk groups an accelerated schedule is used. Three doses of vaccine are given at 0, 1 and 2 months because it has been shown that there are higher completion rates particularly amongst those who are less compliant (e.g. PWID). The improved compliance will probably offset against the slightly reduced immunogenicity of this accelerated schedule compared with the 0, 1 and 6 month schedule. Giving a booster after a year where possible will provide a similar immune response.

If the individual is considered to be at more immediate risk then a super accelerated course can be used with three doses given on day 0, 7 and 21. A fourth dose would be given 12 months after the first dose to ensure long term protection. This schedule is licensed in adults over 18 and is particularly useful for people travelling to areas of high endemicity, prisoners and PWID. It can also be used off license for those aged 16–18 where it is important to provide rapid protection and achieve maximum compliance.

It is believed that in immunocompetent individuals following a successful vaccination course that immunity against hepatitis B lasts for around 30 years. The WHO in 2017 stated that there was no need for a booster dose of hepatitis B vaccine in routine immunization programmes.

For health care workers the 0, 1, 6 month schedule is preferred unless they are going to be engaging in exposure prone procedures in which case a more rapid schedule can be used. A blood test should be done 8–12 weeks after the third dose of vaccine. If the titre is >10 miU/mL then an adequate response has been achieved. In the UK a further dose of vaccine is given at 5 years. In the USA, if an initial adequate response has been achieved, then no further doses of vaccine are considered necessary for Health care workers.

Patients with chronic renal failure or who are on hemodialysis may have poor immunological memory and require further boosts if titres fall below 10 miU/mL.

Post Exposure Prophylaxis

Hepatitis B vaccine administration after exposure varies according to the timing of the incident, the degree of risk involved, and whether the individual has already been partly or fully vaccinated as can be seen in Table 10.3 below.

Hepatitis B specific Immunoglobulin (HSIG) may be used either alone or in conjunction with vaccine. The exact dose given is age-dependent, but must be administered by deep intra-muscular injection in a different site from the vaccine. In an adult, this is usually into the gluteus muscle. If HBIG is being given together with hepatitis B vaccine then it should be given at the same time, ideally within 24 h of an exposure, but can be considered up to 7 days after. It is also used for neonates born to mothers who are HBeAg-positive where the risk of vertical transmission is greatest.

Between 5% and 10% of adults fail to respond to the routine schedule of vaccine. A further full course of vaccine should be tried before deeming them “non-responders”. It is worth considering using Twinrix as there is evidence that the combination of

Table 10.3 Hepatitis B prophylaxis following exposure—adapted from the Green book Chap. 18 [14]

	Significant exposure		
HBV status of person exposed	Source HBsAg positive	Unknown source	Source HBsAg – ve
Unvaccinated	Accelerated course of Hep B vaccine plus HBSIG with first dose	Accelerated course of Hep B vaccine	Consider course of hepatitis B vaccine especially if at continued risk
Partially vaccinated	One dose of vaccine sat and then finish the course	One dose of vaccine stat and then finish the course	Consider completing the course
Fully vaccinated with primary course	Booster dose of hep B vaccine if last dose ≥1 year ago	Consider booster dose of hep B vaccine if last dose ≥1 year ago	No HBV prophylaxis. Reassure
Known non responder Anti HBS <10 iu 1–2 months after vaccination	HBIG Booster dose of hepatitis B vaccine Repeat HBIG at 1 month	HBIG Consider booster dose of hepatitis B vaccine Repeat HBIG at 1 month	No HBIG Consider booster dose of hepatitis B vaccine

hepatitis A and B vaccines is more immunogenic. Using higher strength (40 μg) hepatitis B vaccine as used in renal patients may also be worth trying in non-responders working in high risk settings. Non responders involved in a high-risk exposure should be given two doses of HBIG administered a month apart and a booster dose of hepatitis B vaccine would also be given. Ideally, the first dose of HBIG should be given within 48 h after exposure and no longer than 2 weeks after exposure.

Management in Custody

For staff or victims in contact with disease, it is wise to have a protocol in place for immediate management and risk evaluation. An example is shown in Fig. 10.1. While healthcare professionals are not expected to administer treatment, it is often helpful to inform persons concerned what to expect (Table 10.2).

Other measures to avoid an exposure include minimizing the risk of exposure by adopting the safe working practices outlined in the "Standard Precautions" section. There should be a protocol in place which explains how the person exposed should be managed and where they need to go to be assessed and treated where necessary. Any potential exposures should be dealt with as soon as possible. Detainees with disease can usually be managed in custody. If the detainee is bleeding, then the cell should be deemed out of action after they have left until it can be professionally cleaned. Contaminated bedding should be dealt with as described previously. If the detainee has chronic HBV and is on an antiviral agent (e.g. tenofovir), then the treatment course should be continued, if possible.

People who inject drugs should be encouraged to be vaccinated and to avoid sharing needles or any other drug paraphernalia (see "Management in Custody" in section "Other Bacteria Associated with Abscess Formation in People who Inject Drugs").

Hepatitis C

Epidemiology and Prevalence

Hepatitis C virus (HCV) is endemic in most parts of the world. In 2015 it was estimated that 71 million people are living with chronic hepatitis C infection. In that same year there were 1.75 million new infections world-wide [15]. As part of the WHO Global Health Sector Strategy the aim is to eliminate all viral hepatitis by 2030.

Seroprevalence studies carried out among blood donors have shown that the highest prevalence exists in Egypt—13% in 2016. This has been ascribed to contaminated needles used in the treatment of schistosomiasis carried out between the 1950s and the 1980s [16].

Intermediate prevalence (1–5%) exists in Eastern Europe, the Mediterranean, the Middle East, the Indian Sub-continent and parts of Africa and Asia. In Western Europe, most of Central America, Australia and limited regions in Africa including South Africa, the prevalence is low (0.2–0.5%). Previously, America was included in the low prevalence group, but a report published in 2015 [17] indicated that up to 5.2 million Americans, i.e. 1.6% of the population, have antibody to HCV, representing either ongoing or previous infection. It also states that HCV accounts for approximately 15% of acute viral hepatitis in America.

Between 0.5–1% of the UK population are chronically infected with hepatitis C meaning that in 2018 there are 160,000 people living with chronic infection. However, within any country, there are certain groups that have a higher chance of carrying HCV. In the UK the most important risk factor of hepatitis C is injecting drug use accounting for 90% of all lab reports where a risk factor was disclosed [18]. In 2016 54% of people who had injected psychoactive drugs and participated in the Unlinked Anonymous Monitoring Survey (UAMS) tested positive for antibodies to hepatitis C. However, only 52% of those surveyed were aware of their status impacting on the number of people who could seek treatment. The survey also revealed that 18% of participants still share needles but this is still a fall when compared with the 23% recorded in 2005.

There has been a 3% fall in the number of deaths from HCV end stage liver disease and hepatocellular carcinoma between 2014 and 2016. This has been attributed to more patients seeking treatment and an improvement in the treatment.

Symptoms and Complications

After an incubation period of 6–8 weeks, the acute phase of the disease lasts approximately 2–3 years. Unlike hepatitis A (HAV) or HBV, the patient is usually asymptomatic; therefore, the disease is often missed unless the individual has reported a specific exposure and is being monitored. Other cases are found by chance, when raised liver enzymes are found on a routine blood test.

A “silent phase” follows the acute phase when the virus lies dormant and the liver enzymes are usually normal. This period lasts approximately 10–15 years.

Reactivation may then occur. Subsequent viral replication damages the hepatocytes, and liver enzymes rise to moderate or high levels.

Antibodies develop 4–6 weeks after the acquisition of the virus, with 97% having detectable antibodies by 6 months. RNA can be detected by PCR 2–3 weeks after acquisition of the virus.

Eighty percent of individuals who are HCV antibody-positive are infectious, regardless of the levels of their liver enzymes. Approximately 80% of people develop chronic infection, one fifth of whom progress to cirrhosis. There is a much stronger association with hepatocellular carcinoma than with HBV. An estimated 1.25–2.5% of patients with HCV-related cirrhosis develop liver cancer [19]. Less than 2% of chronic cases resolve spontaneously.

Routes of Transmission

The main route of acquisition for hepatitis C is through injecting drug use, unsafe injection practice, and unscreened blood transfusions. Transmission through the sexual route is not common and only appears to be significant if there is repeated exposure with one or more people infected with HCV [18]. Mother-to-baby transmission is not common, but has been reported [20]. Theoretically, household spread is also possible through sharing contaminated toothbrushes or razors.

Since the disease is often silent, there is a need to raise awareness among the general population on how to avoid infection and to encourage high-risk groups to be tested. Healthcare professionals should also be educated to avoid occupationally acquired infection. An example of good practice is contained within the document 'Hepatitis C strategy for England', issued by the Department of Health in 2002 [19].

Risks from Exposure from HCV RNA-Positive Person

Blood or bloodstained body fluids need to be involved for a risk to occur. Saliva alone is not deemed to be a risk. The risk from a single needlestick incident is 1.8% (range 0–7%). Contact through a contaminated cut is estimated at 1%. For penetrating bite injuries, it is only considered a risk if blood is involved. Blood or bloodstained body fluids have to be involved in transmission through mucous membrane exposure. This may account for the lower than expected prevalence among the gay population.

Management in Custody

Staff/Victims in Contact with Disease

Follow the immediate management flow chart, making sure all available information is obtained. Inform the designated hospital and/or specialist as soon as possible. If the contact is known and is thought to be immunocompromised, and he or she has consented to provide a blood sample, it is important to tell the specialist, as their antibody tests may be spuriously negative. In this instance, a different test should be used (polymerase chain reaction [PCR] which detects viral RNA).

The staff member/victim will be asked to provide a baseline sample of blood ideally within 48 h of the exposure. Further samples may be taken at 4–6 weeks and again at 12 weeks. If tests are negative at 12 weeks, but the risk was deemed high, then follow-up may continue for up to 24 weeks. If any of the follow-up samples are positive, then the original baseline sample will be tested to ascertain whether the infection was acquired through the particular exposure.

Treatment of hepatitis C infection has been improved more recently with the use of Direct Acting Antiviral agents e.g. sofosbuvir. These drugs act by targeting non-structural proteins of the virus which disrupts viral replication and infection. They can be given orally, for shorter durations and have an improved safety profile over the pegylated interferons used previously and can cure the infection within 2–3 months. Treatment is usually not started till after 6 months as between 15–45% of people can spontaneously clear the virus in the acute phase. Prior to these drugs being developed Genotype 1 was notoriously difficult to treat. Now with a combination of drugs there is a cure rate of over 90%. Recovery from hepatitis C does not confer immunity and it is possible to become infected again [21].

Co-infection with HIV also occurs and in 2015 worldwide there was around 2.3 million living with both HCV and HIV. In the UK data studied between 2008 and 2014 showed that around 4% of people with HCV were co infected with HIV. More than 84% of them were male, and 66% were of white ethnicity. Two thirds of those who were co-infected were diagnosed with HIV ≥6 months before HCV [22].

Detainees with disease: Unless they are severely ill, detainees can be managed in custody. Special precautions are only required if they are bleeding. Custody staff should wear gloves if contact with blood is likely. Contaminated bedding should be handled appropriately and the cell cleaned professionally after use. Medication should be continued wherever possible.

Hepatitis D (Delta Agent)

This defective transmissible virus discovered in 1977 requires HBV for its own replication. At least 5% of people with chronic hepatitis B are co-infected with HDV meaning that about 15–20 million people world-wide are infected. High prevalence areas include Central and West Africa, Central and Northern Asia, Vietnam, Mongolia, Pakistan, Japan and Chinese Taipei, the Pacific islands of Kiribati and Nauru, the Middle East, Eastern Europe, the Amazon Basin and Greenland. The number of cases has been falling since the 1980s with the introduction of a successful global hepatitis B immunization program [23].

HDV is associated with acute (co-infection) and chronic hepatitis (superinfection) and can exacerbate pre-existing liver damage caused by HBV in as little as 5 years. The routes of transmission and at-risk groups are the same as for HBV. Staff/victims in contact with a putative exposure and detainees with disease should be managed as for HBV. Current guidelines advise treatment with pegylated Interferon-alpha for 28 weeks, but this would not be practical to continue in the custodial setting [23, 24].

Human Immunodeficiency Virus

Epidemiology and Prevalence

HIV was first identified in 1983—2 years after the first reports were made to the CDC Atlanta, GA, of an increased incidence of two unusual diseases (Kaposi's sarcoma and *Pneumocystis carinii* pneumonia) occurring among the gay population in San Francisco. The scale of the virus gradually emerged over the years, and by the end of 2016, there was an estimated 36.7 million people throughout the world living with HIV or AIDS. Over 80% of the world total live in Africa and India [25].

By the end of 2015 the number of people living with HIV in the UK was estimated at 101,200 with around 13,500 (13%) unware of their infection. The overall HIV prevalence in the UK is about 0.16% [26].

The number of new diagnoses has continued to fall over the past 10 years with a marked decrease in 2016 and 2017. From 2017 data the total number of new HIV diagnoses was 4363 with most among men who have sex with men (2330). This still represents a 30% drop since 2015. Around 1400 new cases were diagnosed in heterosexual woman and around 1000 new cases in heterosexual men. PWIDs have remained consistently low with only 140 new diagnoses being made in 2017 [27]. This equates to about 1 in 100 PWID who are living with HIV. Most are accessing antiviral treatment but are more likely to be diagnosed late [8].

The proportion of people being diagnosed at a late stage of infection (CD4 count <350 cells/mm^3 at diagnosis) remains high at around 40%. This is significant as when a diagnosis is made late there is a tenfold increased risk of death within a year of diagnosis and an increased risk of onward transmission. The highest risk group for late diagnosis was black African heterosexual men (69%) and the lowest rates were among gay and bisexual men (33%) [27].

UK data collected in 2017 showed that 98% of persons seen for HIV care are receiving anti-retroviral therapy (ART) compared with 79% in 2008 (Table 10.4).

Table 10.4 Persons seen for HIV care in the UK by ethnicity and probable routes of exposure (2017)

	MSM (%)	Heterosexual (%)	IDU (%)	Mother to child (%)
White	84	25.6	87.5	9.3
Black African	1.7	56.9	2	70.9
Black Caribbean	1.99	4.06	3.3	1.6
Asian	3.6	3.8	1.8	4.3

Taken from National HIV surveillance data tables [28]

Window Period for HIV

Following infection with HIV there is a period of time when the person is very infectious but an HIV antibody test could be negative. This is known as the window period, which for a fourth generation antigen/antibody test is about 4 weeks. At this time about 95% of patients will test positive. By 12 weeks the figure is 99.9%. The earliest point where antibodies could be detected is 2 weeks.

PCR can be used to measure the viral load and this can be detected as early as 7 days after infection. The higher the viral load the more likely the person will have seroconversion symptoms. At the same time as the viral load becomes detectable the p24 viral antigen is also present in the blood. A negative p24 and viral load early on in infection do not mean that the person has not got HIV. Usually an antibody test is conducted 4 weeks after exposure and if it is negative it is repeated at 12 weeks.

During the acute phase of the infection, between 50–80% of people experience a sero-conversion “flu-like” illness. In some people the symptoms are so mild that they may be missed and in 20% they get nothing at all. The individual is infectious at this time, as viral antigen (p24) and viral particles are present in the blood. As antibodies start to form, the virus disappears and the individual enters the latent phase. They are non-infectious and remain well for a variable period of time (7–15 years). Development of the AIDS marks the terminal phase of disease. Viral antigen re-emerges and the individual is once again infectious. With the development of effective ART patients who take a combination of drugs are very unlikely to develop AIDS. Treatment has changed HIV from being a fatal disease to being a chronic and very manageable condition.

Routes of Transmission

Parenteral transmission includes needle stick injuries, bites, unscreened blood transfusions, tattooing, acupuncture and dental procedures where equipment is inadequately sterilised. Risk of transmission is increased with deep penetrating injuries with hollow bore needles that are visibly bloodstained, especially when the device has previously been in the source patient’s (contact) artery or vein. Other routes include mucous membrane exposure, (eyes, mouth and genital mucous membranes) and contamination of broken skin.

The higher the viral load in the contact, the greater the risk of transmission. This is more likely at the terminal stage of infection unless the patient is being treated. HIV is transmitted mainly through blood or other body fluids that are visibly bloodstained with the exception of semen, vaginal fluid and breast milk. Saliva alone is most unlikely to transmit infection. Therefore, people who have sustained penetrating bite injuries can be reassured that they are not at risk providing the contact was not bleeding from the mouth at the time.

Risk of Seroconversion

The risk from a single percutaneous exposure from a hollow bore needle is low (<3 in 1000) and a single mucocutaneous exposure is even less likely to result in infection (<1 in 1000).

The risk from sexual exposure varies, though it appears that there is a greater risk with receptive anal intercourse compared with receptive vaginal intercourse [29, 30] (see Table 10.5).

Body Fluids Containing HIV

High-risk fluids include blood, semen, vaginal fluid and breast milk. There is little or no risk from saliva, urine, vomit or faeces unless they are visibly bloodstained. Other fluids that constitute a theoretical risk include CSF, peritoneal, pleural, synovial or pericardial fluid.

Management in Custody of Staff/Victims in Contact with Disease

Management in custody of staff/victims in contact with disease includes following the immediate management flow chart (Fig. 10.1) and contacting the designated hospital/specialist with details of the exposure. Where possible, obtain a blood sample from the contact. Like HBV and HCV, blood samples taken for HIV testing can only be taken with informed consent in the United Kingdom. There is no need to go into details about the meaning of the test, but the contact should be encouraged to attend the genito-urinary department (or similar) of the designated hospital to discuss the test results. Should the contact refuse to provide a blood sample, then any

Table 10.5 Risks of HIV transmission from a known HIV positive individual

Type of exposure	Estimated risk of HIV transmission[a]
	Per exposure (%)
Blood transfusion (one unit)	90–100
Sharing injection equipment	0.63
Needle stick injury	0.3
Human bite	<0.001
Receptive anal intercourse	0.138
Receptive vaginal intercourse	0.08%
Insertive anal intercourse	0.06–0.11
Insertive penile vaginal intercourse	0.03–0.09
Receptive oral sex (fellatio)	0–0.04

Adapted from the BASHH guidelines [30]

[a]This assumes that the HIV positive person has a detectable viral load and is not on ART

Table 10.6 PEP management following a potential HIV exposure

		HIV status		
	HIV positive		Unknown HIV status	
	HIV VL unknown/	HIV VL undetectable	From high prevalence	From low prevalence
	>200 copies/mL	<200 copies/mL	Country or risk group	Country or risk group
	For >6 months			
Receptive anal sex	R	NR	R	NR
Insertive anal sex	R	NR	Consider	NR
Receptive vaginal sex	R	NR	Consider	NR
Insertive vaginal sex	Consider	NR	Consider	NR
Fellatio with or without ejacualtion	NR	NR	NR	NR
Splash of semen in eye	NR	NR	NR	NR
Sharing of injection equipment	R	NR	Consider	NR
Human bite	NR	NR	NR	NR
Needlestick from a discarded needle in the community			NR	NR
Occupational needlestick	R	NR	Consider	NR

R recommended, *NR* not recommended

information about their lifestyle, ethnic origin, state of health, etc. may be useful for the specialist to decide whether post-exposure prophylaxis (PEP) should be given to the recipient. Where saliva only is involved in a penetrating bite injury, there is every justification to reassure the recipient that there is little risk of acquiring HIV. However, it is still wise to take advice from a specialist. Table 10.6 shows the various exposures and whether post exposure prophylaxis (PEP) would be recommended.

In the UK, the current recommended regime for PEP is one Truvada tablet (254 mg tenofovir and 200 mg emtricitabine) once a day plus raltegravir twice a day for 28 days [30].

Treatment should be started as soon as possible after exposure and ideally within 24 h, but it can be considered for up to 72 h. It is usually given for 4 weeks unless the contact is subsequently identified as HIV negative or the recipient develops tolerance or toxicity occurs.

In the UK high risk countries or groups would include men who have sex with men (MSM) and PWID from high risk countries e.g. Eastern Europe, and Central Asia. It would also include individuals who have immigrated to the UK from high risk countries particularly sub Saharan Africa.

If the source states that they are HIV positive, and are being treated, then it is important to establish what the viral load, resistance profile and treatment history is. For the recipient not to need PEP, if the viral load of the source is reported as undetectable it has to have been less than 200 copies/mL for at least 6 months. Where there is any uncertainty about the results or doubt as to compliance with ART then PEP should be given after unprotected anal intercourse. Routine blood test monitoring is not recommended for raltegravir based PEP if baseline bloods are normal and there is no clinical indication.

Other useful information that may influence the decision whether to treat with the standard regime or use alternative drugs include interaction with other medications that the recipient may be taking or if the contact has been on anti-retroviral therapy which has not been sustained or drug resistance is suspected.

PEP is not considered for exposure to low or no risk fluids through any route, nor where the source is unknown, e.g. a discarded needle. Despite the appropriate use and timing of PEP, there have been reports of failure [31, 32].

Management in Custody of Detainees with HIV

Unless they are severely ill, they can be kept in custody. Every effort should be made to continue any treatment they may be receiving. Apply standard precautions when dealing with the detainee and ensure that contaminated cells and/or bedding are managed appropriately.

Transmission Through Contact with Lesions or Organisms

Varicella (Chicken Pox)

Epidemiology and Prevalence

Cases of this highly infectious disease occur throughout the year, but are more frequent in winter and early spring. This seasonal endemicity appears to be blurring with global warming but in the UK it reaches a peak between March and May. In the UK, the highest prevalence occurs in the 4–10 years age group. Ninety percent of the population over the age of 40 are immune [33]. A similar prevalence has been reported in other parts of Western Europe and the USA. In South East Asia, Varicella is mainly a disease of adulthood [34]. Therefore, people born in these countries who have moved to the UK are more likely to be susceptible to chicken pox.

There is a strong correlation between a history of chicken pox and serologic immunity (97–99%). Most adults born and living in industrialised countries with an uncertain or negative history of chicken pox are also seropositive (70–90%). In March 1995, a live-attenuated vaccine was licensed for use in the USA and a policy for vaccinating children and susceptible healthcare personnel was introduced. In the summer of 2002 in the UK, GlaxoSmithKline launched a live-attenuated vaccine called Varilrix. In December 2003, the Department of Health, following advice from the Joint Committee on Vaccination and Immunisation (JCVI), recommended that the vaccine be given for non-immune healthcare workers who are likely to have direct contact with individuals with chicken pox. Any healthcare worker with no previous history of chicken pox should be screened for immunity, and if no antibodies are found, they should receive two doses of vaccine 4–8 weeks apart. The other group of people who would be considered for vaccination are close contacts (e.g. family members) of patients with weakened immune systems who would be at high risk of developing complications.

The vaccine is still not currently recommended for children in the UK and should not be given during pregnancy. The rationale behind not vaccinating in the UK stems from the concern that if children are vaccinated then the virus is not circulating. This means that children who have not been vaccinated will be more susceptible as adults when the disease can be more serious or in pregnancy when the baby can be harmed. As adults, being exposed to natural disease from infected children boosts immunity and protects the adults from developing shingles. Therefore it is likely that the number of cases of shingles would rise if children were routinely vaccinated. Other countries, including the USA and Australia, disagree with this policy and vaccinate their children.

Incubation Period and Symptoms

Following an incubation period of 7–21 days (this may be shorter in the immunocompromised), there is usually a prodromal "flu-like" illness which lasts 1–2 days before the onset of the rash. This coryzal phase may be absent particularly in young children. The lesions typically appear in crops; rapidly progressing from red papules through vesicles to open sores that crust over and separate by 10 days. They appear on the face and scalp and spread on to the trunk and then the limbs. The distribution of the rash is centripetal, i.e. more over the trunk and face than on the limbs which is the converse of small pox. In adults, the disease is often more severe with lesions involving the scalp and mucous membranes of the oropharynx.

Complications

In children, the disease is often mild, unless they are immunocompromised, so are unlikely to experience complications. In adults (defined as 15 years or older), the picture is rather different [35]. Secondary bacterial infection is common, but rarely serious. There is an increased likelihood of permanent scarring. Hemorrhagic chickenpox typically occurs on the 2nd or 3rd day of the rash. Usually, this is limited to bleeding into the skin, but life-threatening melaena, epistaxis or hematuria can occur.

Varicella pneumonia ranges from patchy lung consolidation to overt pneumonitis and occurs in 1 in 400 cases [36]. It can occur in previously healthy individuals (particularly adults), but the risk is increased in those who smoke. Immunocompromised people are at the greatest risk of developing this complication. It runs a fulminating course and is the commonest cause of Varicella-associated death.

Fibrosis and permanent respiratory impairment may occur in those who survive. Any suspicion of lung involvement is an indication for immediate treatment and any detainee or staff member should be sent to hospital. Involvement of the CNS includes a variety of conditions including meningitis, Guillain–Barre and encephalitis. The latter is more common in the immunocompromised and can be fatal.

Complications can also occur in pregnancy—see At-risk groups.

Period of Infectivity

This is taken as 1–3 days before the first lesions appear to the end of new vesicle formation and the last vesicle has crusted over. This typically is 5–7 days after onset, but may last up to 14 days. It is more likely to be prolonged in immunocompromised people.

Routes of Transmission

The primary route is through direct contact with open lesions of chicken pox. However, it is also spread through aerosol or droplets from the respiratory tract. Chicken pox may also be acquired through contact with open lesions of shingles (Varicella zoster), but this is less likely as shingles is less infectious than chicken pox. The secondary infection rate from a household contact with chicken pox can be as high as 90%.

At-Risk Groups

Non-immune individuals are at risk of acquiring disease. Approximately 10% of the adult population born in the UK and <5% of adults in the USA fall into this category. Therefore, it is more likely that if chicken pox is encountered in the custodial setting, it will involve people born outside the UK (in particular South East Asia) or individuals who are immunocompromised and have lost immunity. Non-immune pregnant women are at risk of developing complications.

Pneumonia can occur in up to 10% of pregnant women with chicken pox and the severity appears to be increased in later gestation [37]. They can also transmit infection to the unborn baby [38]. If infection is acquired in the first 20 weeks, there is <3% chance of it leading to congenital Varicella syndrome. This includes limb hypoplasia, microcephaly, cataracts and growth retardation. Mortality estimates are between 1–2%.

Infection in the last trimester can lead to neonatal Varicella unless more than 7 days elapse between onset of maternal rash and delivery when antibodies have time to cross the placenta leading to either mild or inapparent infection in the newborn. In this situation, Varicella immunoglobulin (VZIG) should be administered to the baby as soon as possible after birth [39].

Management in Custody

Staff with chicken pox should stay off work until the end of the infective period (approximately 7–14 days). Those in contact with disease who are known to be non-immune or who have no history of disease should contact the designated occupational health physician. A significant contact would be considered as being in the same room for at least 15 min.

Detainees with visible disease should not be kept in custody if at all possible (especially pregnant women). If this is unavoidable, then non-immune or immunocompromised staff should avoid entering the cell or having close contact with the detainee.

Non-immune immunocompromised or pregnant individuals exposed to chickenpox should seek expert medical advice for the administration of VZIG. Aciclovir (or similar antiviral agent) should be given as soon as possible to immunocompromised people with chicken pox. It should also be considered for anyone over 15 years old who is non immune as they are more likely to develop complications. Immunosuppressed patients who have detectable varicella antibodies will not need VZIG. Second attacks of chicken pox can occur in such people but this is most likely to be due to a fault in cell-mediated immunity.

Do not give ibuprofen as this can cause serious skin infections. Do not give aspirin to under 16 year olds with chicken pox as this can lead to Reyes syndrome which is a serious condition that causes swelling to the liver and the brain. Anyone suspected of severe complications should be sent straight to hospital.

Herpes Zoster (Shingles)

Epidemiology

After chicken pox, the varicella zoster virus lies dormant in the dorsal root or cranial nerve ganglia, but may reactivate and re-emerge typically involving one dermatome [40]. The site of involvement depends on the sensory ganglion initially involved. Shingles is more common over the age of 50, but it can occur in children and is very common in the immunosuppressed at any age. The latter are also more susceptible to secondary attacks and involvement of more than one dermatome. Bilateral zoster is even rarer, but is not associated with a higher mortality.

In the UK, there is an estimated incidence of 1.2–3.4 per 1000-person years [41].

Symptoms

There may be a prodromal period of paresthesia and burning or shooting pains in the involved segment. This is usually followed by the appearance of a band of vesicles. Rarely, the vesicles fail to appear and only pain is experienced. This is known as *zoster sine herpete*. In individuals who are immunocompromised, disease may be prolonged and dissemination may occur but is rarely fatal. The overall fatality rate is estimated as 1/1000 persons over 70 years old.

Shingles in pregnancy is usually mild. The fetus is only affected if viremia occurs before maternal antibody has had time to cross the placenta.

Complications

The most common complication of shingles is post-herpetic neuralgia (PHN) occurring in about 10% of cases. It is defined as pain lasting more than 120 days from rash onset [42]. It is more frequent in people over 50 and can lead to depression as the pain can be very debilitating and is mostly unresponsive to standard pain killers. Other drugs such as pregabalin and amitryptiline may help to alleviate symptoms. Infection of the brain can lead to encephalitis, involvement of motor neurones leading to ptosis, paralysis of the hand, facial palsy or contralateral hemiparesis. Involvement of the oculomotor division of the trigeminal ganglion can cause serious eye problems including corneal scarring.

Period of Infectivity

Shingles is far less infectious than chicken pox and is only considered to be infectious up to 3 days after lesions appear.

Routes of Transmission

Shingles is only infectious following prolonged contact with lesions. Unlike chickenpox, airborne transmission is not a risk.

At-Risk Groups

Individuals who are immunocompromised may reactivate the dormant virus and develop shingles. People who have not had primary Varicella are at risk of developing chicken pox following prolonged direct contact with shingles.

Despite popular belief, it is untrue that immunocompetent people who have had chicken pox develop shingles when in contact with either chicken pox or shingles. Such occurrences are merely coincidental unless immunity is lowered.

Management in Custody

Staff with shingles should stay off work until the lesions are healed unless they can be covered. Staff who have had chicken pox are immune (including pregnant women) and are therefore not at risk. If they are non-immune (usually accepted as those without a history of chickenpox), they should avoid prolonged contact with detainees with shingles. Pregnant non-immune women should avoid contact altogether.

Detainees with disease may be kept in custody and any exposed lesions should be covered. It is well documented that prompt treatment attenuates the severity of the disease, reduces the duration of viral shedding, hastens lesion healing, and reduces the severity and duration of pain. It also reduces the likelihood of developing post-herpetic neuralgia [43]. Prompt treatment with Famciclovir (500 mg tds for 7 days, for example) or acyclovir (800 mg five times a day for 7 days) should be initiated if the onset is 3 days or less. It should also be considered after this time if the detainee is over 50. Pregnant detainees with shingles can be reassured that there is minimal risk for both the mother and the unborn child. Expert advice should be sort before initiating treatment for the mother.

In the UK Zostavax (a live vaccine for shingles) was introduced in September 2013 as a single dose of vaccine for adults aged 70 on 1st September 2013 and aged 79 in the first year as part of a phased catch up. Data from the first 3 years of the program show that there has been a significant reduction in the number of cases of shingles and PHN despite the fact that the vaccine is only about 50% effective [44].

Shingrix is an inactivated shingles vaccine that has been introduced in the USA. This vaccine is given as a two dose course and is reported as being over 90% effective. The uptake has been so great that there have been vaccine shortages while the manufacturers catch up with the unprecedented demand. It has yet to be introduced into the UK.

Scabies

Epidemiology

This tiny parasitic mite (*Sarcoptes scabiei*) has infested humans for over 2500 years. Experts estimate that in excess of 300 million cases occur worldwide each year. The female mite burrows into the skin especially around the hands, feet and male genitalia, in about 2.5 min. Eggs are laid and hatch into larvae that travel to the skin surface as newly developed mites.

Symptoms

The mite causes intense itching which is often worse at night and is aggravated by heat and moisture. The irritation spreads outside the original point of infection due to an allergic reaction to mite feces. This irritation may persist for about 2 weeks after treatment, but can be alleviated by antihistamines.

Crusted scabies is a far more severe form of the disease. Large areas of the body may be involved. The crusts hide thousands of live mites and eggs making them difficult to treat. This so-called Norwegian scabies is more common in the elderly or the immunocompromised, especially those with untreated HIV.

Incubation Period

Following a primary exposure, it takes about 2–6 weeks before the onset of itching. However, further exposures reduce the incubation time to around 1–4 days.

Period of Infectivity

Without treatment, this is assumed to be indefinite. With treatment, the person should be considered infectious until the mites and eggs are destroyed—usually 7–10 days. Crusted scabies is highly infectious.

Management in Custody

Since transmission is through direct skin-to-skin contact with an infected case, gloves should be worn when dealing with individuals suspected of infestation. Usually prolonged contact is needed, unless the person has crusted Scabies where transmission occurs more easily. The risk of transmission is much greater in households where repeated or prolonged contact is likely.

Since mites can survive in bedding of clothing for up to 24 h, gloves should also be worn when handling these items. Bedding should be treated by washing at a temperature of at least 50 °C. Professional cleaning of the cell is only warranted in cases of crusted scabies.

Treatment

The preferred treatment for scabies is either Permethrin cream (5%) or aqueous Malathion (0.5%) [45]. Either treatment has to be applied to the whole body and should be left on for at least 8 h in the case of permethrin and 24 h for Malathion before washing off. Lindane is no longer considered the treatment of choice, as there may be complications in pregnancy [46].

Treatment in custody may not be practical, but should be considered when the detainee is thought to have Norwegian scabies.

Head Lice

General Information

Like scabies, head lice occur worldwide and are found in the hair close to the scalp. The eggs or nits cling to the hair and are difficult to remove, but are not harmful. If you see nits then you can be sure that lice are also present. The latter are best seen when the hair is wet. The lice bite the scalp and suck blood causing intense irritation and itching.

Route of Transmission

They can only be passed from direct hair to hair contact.

Management in Custody

It is only necessary to wear gloves when examining the head for whatever reason. The cell does not need to be cleaned after use, since the lice live on or near skin. Bedding may be contaminated with shed skin so should be handled with gloves and laundered or incinerated.

The presence of live lice is an indication for treatment either by physical removal with a comb or the application of an insecticide. The latter may be more practical in custody. 0.5% aqueous Malathion should be applied to dry hair and washed off after 12 h. The hair should then be shampooed as normal.

Crabs or Body Lice

General Information

They are more commonly found in the pubic, axillary, chest and leg hair. However, eyelashes and eyebrows may also be involved. They are associated with people who do not bath or change clothes regularly. The person usually complains of intense itching or irritation.

Routes of Transmission

The main route is from person to person by direct contact, but eggs can stick to fibers so clothing and bedding should be handled with care (see section below).

Management in Custody

Staff should always wear gloves if they are likely to come into contact with any hirsute body part. Clothing or bedding should be handled with gloves and either laundered or incinerated.

Treatment of a detainee in custody is good in theory but probably impractical as the whole body has to be treated.

Fleas

General Information

Fleas lay eggs on floors, carpets and bedding. In the UK, most fleabites come from cats or dogs. The eggs and larvae fleas can survive for months and are reactivated in response to animal or human activity. Since animal fleas jump off humans after biting, most detainees with fleabites will not have fleas, unless they are human fleas.

Management in Custody

Treatment is only necessary if fleas are seen. After use, the cell should be vacuumed and cleaned with a proprietary insecticide. Any bedding should be removed wearing gloves, bagged and either laundered or incinerated.

Bedbugs

General Information

Bedbugs live and lay eggs on walls, floors, furniture and bedding. If you look carefully, fecal tracks may be seen on hard surfaces. If they are present for long enough, then they emit a distinct odor. Bedbugs are rarely found on the person, but may be brought in on clothing or other personal effects.

Symptoms

Bedbugs bite at night and can cause sleep disturbance.

Management in Custody

The detainee does not need to be treated, but the cell should be deemed out of use until it can be vacuumed and professionally cleaned with an insecticide solution. Any bedding or clothing should be handled with gloves and disposed of as appropriate.

Methicillin-Resistant *Staphylococcus aureus*

Epidemiology

Staphylococcus aureus is commonly carried on the skin or in the nose of healthy people. Approximately 25–30% of the population is colonized with the bacteria, but remain well [47]. From time to time, the bacteria cause minor skin infections that usually do not require antibiotic treatment. However, more serious problems can occur, e.g. infection of surgical wounds, drug injection sites, osteomyelitis, pneumonia or bacteremia. Over the last 50 years, the bacteria have become increasingly resistant to penicillin-based antibiotics [48] and in the last 20 years to an increasing number of alternative antibiotics. These multi-resistant bacteria are known as methicillin-resistant *S. aureus* (MRSA).

MRSA is prevalent worldwide. Like non-resistant staphylococci, it may remain undetected as a reservoir in colonized individuals, but can also produce clinical disease. It is more common among the elderly, debilitated or immunocompromised people or those with open wounds. Clusters of skin infections with MRSA have been reported among injecting drug users since 1981 in America [49, 50] and more recently similar strains have been found in the UK in PWIDs in the community [51]. This may have particular relevance for the healthcare professional when dealing with injecting drug users' ulcers or abscesses. Immunocompetent people rarely get MRSA and should not be considered at risk. Between April 2003 and December 2008, there were 74 recorded cases of a community-acquired MRSA in injecting drug users in England and Wales [52]. A study conducted from the CDC in Atlanta looked at data from injecting drug users between 2005 and 2016. The data showed that PWID are 16.3 × more likely to develop invasive MRSA infections than others.

Data from 2016 in the UK from the mandatory enhanced surveillance showed that 13% of the Methiciliin Sensitive Staphylcoccus Aureus (MSSA) bacteremia and 8.1% of the MRSA bacteremias were associated with injecting drug use [53]. This has increased since 2011 from 6.9% for MSSA and 1.6% for MRSA.

In 2014 in Bristol there was an increase in the number of severe MRSA infections among PWID. A study showed that 8.7% of PWID in Bristol were carriers compared with 1–4% for the UK population in general. The rise in cases was thought to be due to a specific clone and to the increase in injecting outside and into the groin [53].

Route of Transmission

The bacteria are usually spread via the hands of staff after contact with colonized or infected detainees or devices, items (e.g. bedding, towels, soiled dressings) or environmental surfaces that have been contaminated with MRSA-containing body fluids.

Management in Custody

With either known or suspected cases (consider all abscesses/ulcers of injecting drug users as infectious), standard precautions should be applied. Staff should wear gloves when touching mucous membranes, non-intact skin, blood or other body fluids or any items that could be contaminated. They should also be encouraged to wash hands with an antimicrobial agent whether or not gloves have been worn. After use, gloves should be disposed of in a yellow "hazard" bag and not allowed to touch surfaces. Masks and gowns should only be worn when carrying out procedures that generate aerosols of blood or other body fluids. Since this is an unlikely scenario in the custodial setting, they should not be necessary. Gloves should be worn when handling bedding or clothing and all items should be disposed of in the appropriate manner. Any open wounds should be covered as soon as possible. The cell should be cleaned professionally after use if there is any risk that it has been contaminated.

Other Bacteria Associated with Abscess Formation in Injecting Drug Users

Epidemiology

Over the last decade, there has been an increasing awareness of the bacterial flora colonizing injection sites that may potentially lead to life-threatening infection [54].

In 1997, a sudden increase in needle abscesses caused by a clonal strain of Group A *Streptococcus* (GAS) was reported among hospitalized intravenous drug users (IDUs) in Berne, Switzerland [55]. A recent study in the UK showed that the predominant isolate is *S. aureus*, with *Streptococcus* species forming just under one fifth (50% *beta-hemolytic* streptococci) [56].

There have also been reports of both non-sporing and sporing anaerobes (e.g. *Bacteroides* and *Clostridia* species including *Clostridium botulinum*) [57, 58]. In terms of numbers, in 2003–2004, injecting drug use was one of the most important risk factors for Group A streptococcal infection in the United Kingdom accounting for 20%. Over subsequent years the number of cases fell [52]. However, in 2016/17 there has been an increase in invasive Group A Streptococcal infections (iGAS) amongst homeless people and PWID in England and Wales. In Brighton, Gloucestershire, Bristol and London there was an emm66 cluster and more recently an emm99 cluster in Bournemouth which is spreading more widely [53].

In 2000, laboratories in Glasgow were reporting isolates of *C. novyi* among IDUs with "serious unexplained illness". By 12 June 2000, a total of 42 cases (18 definite and 24 probable) had been reported. A definite case was defined as an IDU with both severe local and systemic inflammatory reactions. A probable case was defined as an IDU who presented to hospital with an abscess or other significant inflammation at an injecting site and had either a severe inflammatory process at or around an injection site or a severe systemic reaction with multiorgan failure and a high white cell count [59].

In the UK, the presence of *C. botulinum* in infected injection sites is a relatively new phenomenon. Up to the end of 1999, there were no cases reported to the Public Health Laboratory Service (PHLS). Since then the number has increased with a total of 13 cases in the UK and Eire being reported since the beginning of 2002. It is thought that these cases are associated with contaminated batches of heroin. Simultaneous injection of cocaine increases the risk by encouraging anaerobic conditions. Anaerobic flora in wounds may have serious consequences for the detainee but the risk of transmission to staff is virtually non-existent. By the end of 2008, a cumulative total of 132 suspected cases had been reported from the United Kingdom, with 86% of cases occurring in England. Four cases were reported in 2008 alone [52]. In 2016 wound botulism still continues to be a problem albeit rare with seven cases being reported and one case of confirmed tetanus [8].

In December 2009, two injecting drug users in Scotland died from anthrax contaminated heroin. Following this, two further deaths occurred in England in February 2010. An alert was issued first by the Department of Health and then, by the National Treatment Agency warning any drug user of the possible risks. Spores from the bacillus anthracis can contaminate heroin without any obvious signs. Anthrax can be acquired by injecting, smoking or inhaling heroin. Obvious symptoms include excessive swelling and redness at injection sites, fever, headache or shortness of breath when the heroin is smoked. Users are advised to go straight to the Emergency Department if they are at all worried. Such infections with spore forming bacteria will always occur from time to time. Healthcare professionals should be mindful at all times. There were no reported cases of anthrax in 2016.

Management in Custody

Staff should be reminded to wear gloves when coming into contact with detainees with infected skin sites exuding pus or serum and that any old dressings found in the cell should be disposed of into the yellow bag marked “clinical waste” in the medical room. Likewise, any bedding should be bagged and laundered or incinerated after use. The cell should be deemed out of use and professionally cleaned after the detainee has gone.

The healthcare professional managing the detainee should clean and dress open wounds as soon as possible to prevent the spread of infection. It may also be appropriate to start a course of antibiotics if there is abscess formation, signs of cellulitis and/or the detainee is systemically unwell. However, infections can often be low-grade because the skin, venous and lymphatic systems have been damaged by repeated penetration of the skin. In these cases, signs include lymphoedema, swollen lymph glands and darkly pigmented skin over the area. Fever may or may not be present, but septicemia is uncommon unless the individual is immunocompromised (e.g. HIV positive). Co-Amoxiclav is the preferred treatment of choice as this covers majority of staphylococci, streptococci and anaerobes (the dose used is dependent on the degree of infection).

Necrotizing fasciitis and septic thrombophlebitis are rare but life-threatening complications of intravenous drug use. Any detainee suspected of either of these needs hospital treatment. Advice about harm reduction should also be given. This includes encouraging drug users to smoke rather than inject or at least to advise them to avoid injecting into muscle or skin. Although most injecting drug users are aware of the risk of sharing needles, they may not realize that sharing any drug paraphernalia could be hazardous. Advice should be given to use the minimum amount of citric acid to dissolve the heroin as the acid can damage the tissue under the skin allowing bacteria to flourish. Drugs should be injected at different sites using fresh works for each injection. This is particularly important when “snowballing” as crack cocaine creates an anaerobic environment. Medical help should be requested if any injection site become painful and swollen or shows signs of pus collecting under the skin. Much work has been done to vaccinate PWID against hepatitis B but there is always an opportunity to check their status and encourage them to get vaccinated if they have not had it. Hepatitis A vaccine should also be encouraged as cases of the disease do get reported in PWID.

Another serious but relatively rare problem is the risk from broken needles in veins. Embolization can take anything from hours to days or even longer if it is not removed. Complications may include endocarditis, pericarditis or pulmonary abscesses [60, 61]. PWID should be advised to seek medical help as soon as possible, and should such a case present in custody, then the detainee should be sent straight to hospital.

Management of Human and Dog Bites

The HCP may encounter bites in four circumstances:

1. During the examination of victims of assault (both children and adults) where presentation is more likely to be late
2. Among police officers bitten during the arrest of a detainee
3. In detainees during the arrest if dogs have been used
4. Where detainees have been involved in a fight either around the time of arrest or earlier

A detailed forensic examination of bites is given in Chap. 4. With any bite that has penetrated the skin, the goals of therapy are to minimize soft tissue deformity and to prevent or treat infection.

Epidemiology

In the UK and USA, dog bites represent approximately three-quarters of all bites presenting to Emergency departments [62]. A single dog bite can produce up to 220 psi of crush force in addition to the torsional forces as the dog shakes its head. This can result in massive tissue damage. Human bites may cause classical bite marks or puncture wounds (e.g. impact of fists on teeth) resulting in crush injuries.

Rates and Risks of Infection

An estimated 10–30% of dog bites and 9–50% of human bites lead to infection. Compare this with an estimated 1–12% of non-bite wounds managed in Emergency Departments.

The risk of infection is increased with puncture wounds, hand injuries, full thickness wounds, wounds requiring debridement, and those involving joints, tendons, ligaments or fractures.

Co-morbid medical conditions such as diabetes, asplenia, chronic edema of the area, liver dysfunction, the presence of a prosthetic valve or joint, and an immunocompromised state may also increase the risk of infection.

Other Complications of Bites

Infection may spread beyond the initial site, leading to septic arthritis, osteomyelitis, endocarditis, peritonitis, septicemia and meningitis. Inflammation of the tendons or synovial lining of joints may also occur. If enough force is used, bones may be fractured or the wounds may be permanently disfiguring.

Initial Management

Encourage the wound to bleed unless it is already bleeding and irrigate with warm running water. Assessment as to whether hospital treatment is necessary should be made as soon as possible. Always refer if the wound is bleeding heavily or fails to stop when pressure is applied. Penetrating bites involving arteries, nerves, muscles, tendons, the hands or feet or resulting in a moderate-to-serious facial wound, or crush injuries also require immediate referral.

If management within custody is appropriate, then ask about current tetanus vaccine status, HBV vaccination status and known allergies to antibiotics.

A full forensic documentation of the bite should be made as detailed in Chap. 4.

Note if there are clinical signs of infection such as erythema, edema, cellulitis, purulent discharge, or regional lymphadenopathy. Cover the wound with a sterile, non-adhesive dressing. Wound closure is rarely advised in primary care and is not generally recommended as data suggest that this may increase the risk of infection. This is particularly relevant for non-facial wounds, deep puncture wounds, bites to the hand, clinically infected wounds, and those occurring more than 6–12 h before presentation. Head and neck wounds in cosmetically important areas may be closed if less than 12 h old and not obviously infected. This should only be done in a tertiary setting by an appropriately trained health care professional.

Pathogens Involved

1. Bacteria
   - Dog bites—*Pasteurella canis, P. multocida, S. aureus*, other staphylococci, *Streptococcus* species, *Eikenella corrodens*, *Corynebacterium* species and anaerobes including *Bacteroides fragilis* and *C. tetani*.
   - Human bites—*Streptococcus* species, *S. aureus, E. corrodens*, and anaerobes including *Bacteroides* (often penicillin resistant), peptostreptococci species, and *C. tetani*. TB and syphilis may also be transmitted.
2. Viruses
   - Dog bites—Outside of the UK, Australia and New Zealand, rabies should be considered. In the USA, domestic dogs are mostly vaccinated against rabies [63], and police dogs have to be vaccinated, so the most common source is from racoons, skunks and bats.
   - Human bites—HBV, HCV, HIV, and herpes simplex.

Antibiotic Prophylaxis

Prophylactic antibiotics should be prescribed for all human and cat bites less than 72 h old even if there is no sign of infection. For other animal bites then antibiotics should be prescribed if the bite involves the hand, foot and face, joints, tendons or where there are suspected fractures. Antibiotics should also be prescribed for people who are at increased risk of infection e.g. diabetes, asplenia, cirrhosis, immunosuppressed, or who have a prosthetic joint or valve.

Co-amoxiclav (amoxycillin and clavulanic acid) is the first choice for both prophylaxis and treatment and should be given for 7 days. For adults, the recommended dose is 500/125 mg tds and for children 40 mg/kg tds (based on amoxycillin component). If the individual is known or suspected to be allergic to penicillin, then a tetracycline (e.g. doxycycline 100 mg bd) and metronidazole (500 mg tds) or erythromycin (or clarithromycin) and metronidazole can be used. Specialist advice should be sort for children who are penicillin allergic and for pregnant women.

Anyone with severe infection or who is clinically unwell should be referred to hospital. Tetanus vaccine should be given if the primary course or last booster was more than 10 years ago. Human tetanus immunoglobulin should be considered for tetanus-prone wounds (e.g. soil contamination, puncture wounds, signs of devitalized tissue, or for wounds sustained more than 6 h old). If the person has never been immunized or is unsure of their tetanus status, then a full three-dose course, spaced at least a month apart, should be given.

Management of Suspected Viral Infections from Human Bites

Penetrating bite wounds that involve only saliva may present a risk of HBV if the perpetrator belongs to a high-risk group. For management see "Disease Prevention" and "Management in Custody" in section "Hepatitis B". HCV and HIV are only a risk if blood is involved. The relevant management is dealt with in "Management in Custody" in section "Hepatitis C" and "Management in Custody of Staff/Victims in Contact with Disease" in section "Human Immunodeficiency Virus". Consultation with a virologist or communicable diseases doctor should be sought at the earliest opportunity.

Infections Transmitted Through the Respiratory Route

General Information

Respiratory tract infections are common, are usually mild and self-limiting, although they may require symptomatic treatment with paracetamol or a non-steroidal anti-inflammatory. These include the common cold (80%—rhinoviruses and 20%—coronaviruses), adenoviruses, influenza and parainfluenza, and during the summer and early autumn—enteroviruses. Special attention should be given to asthmatics or the immunocompromised detainee, as infection in these people may be more serious particularly if the lower respiratory tract is involved.

The following section includes respiratory pathogens of special note as they may pose a risk to both the detainee and/or staff who come into close contact.

Meningococcal Meningitis (*Neisseria meningitidis*)

General Information and Epidemiology

There are six meningococcal capsular groups of *Neisseria meningitidis*: A, B, C, W135 X and Y that are responsible for nearly all invasive infections in humans. The prevalence of the different types varies from country to country. In the UK nasopharynx carriage prevalence is around 5% in infants and reaches a peak at around aged 19 of 24%. The rate declines to about 8% in adulthood. The risk of invasive disease following acquisition varies with environmental and host factors. Established carriers rarely get invasive disease.

In 1999 the MenC conjugate vaccine was introduced and vaccination programs over the years have substantially reduced the number of cases in the under 18 s. A secondary benefit of the reduced carriage rate in immunized adolescents was to reduce the number of cases in older age groups. MenC has remained well controlled with 20–30 cases occurring annually over the last 10 years. Of the current cases many occur in people who were born outside the UK and who may not have been vaccinated.

Cases of MenW were associated with the Hajj pilgrimage in the early 2000 but this has been controlled by the mandatory introduction of MenACWY vaccination for all pilgrims going to Saudi Arabia. Since then MenW have accounted for about 5% of invasive disease until 2010 when cases increased with a peak in 2015/16 of more than 200 cases in that year. The cause was identified as a hypervirulent strain which was responsible for severe disease with high fatality rates in South America, From August 2015 the UK introduced an emergency MenACWY vaccination program for adolescents. The conjugate vaccine is now routinely given to 14 year olds with a catch up for 14–18 years and new university students up to their 25th birthday. This has been effective as by the end of August 2016 there was a 69% decrease of MenW disease in those who left school in the summer of 2015.

MenB disease has declined in the UK over the last 10 years. Around 26% of MenB cases occur in the first year of life with 60% occurring during the first 5 years. A second smaller peak occurs in 15–19 year olds. Since September 2015 MenB vaccine has been incorporated into the UK childhood program and there has already been a fall in the number of cases [64].

Symptoms

Following an incubation period of 3–5 days [65, 66], disease onset may either be insidious with mild prodromal symptoms or florid. Early symptoms and signs include malaise, fever and vomiting. Severe headache, neck stiffness, photophobia, drowsiness and a rash may develop. The rash may be petechial or purpuric and characteristically does not blanche under pressure. Meningitis in infants is more likely to be insidious in onset and lack the classical signs. In approximately 15–20% of cases, septicemia is the predominant feature. Even with prompt antibiotic treatment, the case fatality rate is 3–5% in meningitis and 15–20% in those with septicemia [33]. Meningococcal meningitis and septicemia are statutorily notifiable under health protection legislation in the UK. All cases where a diagnosis of meningococcal disease is suspected should be reported to the Health Protection Team without delay.

Period of Infectivity

A person should be considered infectious until the bacteria are no longer present in nasal discharge. With treatment, this is usually approximately 24 h.

Routes of Transmission

The disease is spread through infected droplets or direct contact from carriers or those who are clinically ill. It requires prolonged and close contact, so is a greater risk for people who share accommodation, utensils, and intimate kissing. It must also be remembered that unprotected mouth-to-mouth resuscitation can also transmit disease but this should never occur in the custody setting where pocket masks and bag valve masks are available.

The risk of illness in close contacts is highest in the first 48 h of disease onset in the index case. The absolute risk of developing a second case of invasive meningococcal disease (IMD) is 1/300 if no chemoprophylaxis is given. Antibiotics are given to close contacts of cases to eliminate established carriage and to eradicate carriage in those who have newly acquired the invasive strain.

Transient contact with an index case such as during travel in a plane, bus or car does not justify prophylaxis. European Centre for Disease Prevention and Control (ECDC) guidance indicates flight contact tracing only if there was intense exposure to nasopharyngeal sections. In the USA antibiotic prophylaxis would be recommended for passengers seated next to an index case for more than 8 h.

Management in Custody

Anyone suspected of having meningococcal disease should be sent straight to hospital. Antibiotic prophylaxis is only recommended for those who have had prolonged close contact with a case during the 7 days before the onset of illness, or for those who have had transient close contact but have been directly exposed to large droplets and respiratory excretions around the time of hospitalization. The latter situation may occur in custody with a detainee who is clinically unwell and who coughs into the staff member's face. Respiratory droplets in the eyes is not a case for antibiotics but there is a low risk of meningococcal conjunctivitis. Staff exposed in this way should be advised to seek medical treatment promptly if conjunctivitis develops within 10 days of exposure. Any staff member who thinks they have been exposed should seek advice from their Occupational Health Department or local Health Protection Team.

Ciprofloxacin is the prophylactic antibiotic of choice in the UK, for all age groups and in pregnancy. It is given as a single dose and does not interfere with oral contraceptives and is readily available in pharmacies. In cases of ciprofloxacin hypersensitivity rifampicin is a viable alternative but this requires multiple doses, can inhibit oral contraceptives and is only available through hospital pharmacies. Antibiotic prophylaxis should be given as soon as possible and ideally within 24 h after the diagnosis of the index case. However, antibiotics and vaccine may still be considered up to 28 days later.

Meningococcal vaccination is offered to those at prolonged contact with the index cases. This provides longer term protection and can reduce the chance of late cases. Health care workers or those working in custody suites do not need to be vaccinated routinely because of the low risk of exposure. The threshold for given chemoprophylaxis would however be lowered in those staff members who were immunocompromised [64].

Tuberculosis

Prevalence and Epidemiology

Human tuberculosis (TB) is caused by infection with *Mycobacterium tuberculosis, M. bovis* or *M. africanum*. It is a notifiable disease under legislation specific to individual countries, for example in the UK this comes under the Public Health (Control of Disease) Act 1984. In 1993, the WHO declared TB to be a global emergency with an estimated seven to eight million new cases and three million deaths occurring each year, the majority of which were in Asia and Africa.

In 2017 it was estimated that ten million new cases of TB occurred globally (5.8 million men, 3.2 million women and one million children). There were cases in all countries and all age groups but overall 90% were adults (>15) and 9% had concomitant HIV and of those 72% were living in Africa. Two thirds of the TB cases were from eight countries, India, China, Indonesia, Philippines, Pakistan, Nigeria, Bangladesh, and South Africa. Only 6% of global cases were in the WHO European region (3%) and WHO Region of the Americas (3%) [67].

World-wide in 2017 it is estimated that around 558,000 people developed TB that was resistant to Rifampicin (RR-TB) and of these 82% had multi-drug resistant TB (MDR-TB), India, China and the Russian Federation accounted for almost 50% of the cases with India accounting for 24%. Some 8.5% of the MDR-TB cases in 2017 were estimated to have extensively drug resistant TB (XDR-TB).

About 1.7 billion people in the world have latent TB that can be reactivated and are therefore at risk of active disease. This represents just under a quarter of the world population.

TB in England

In 1999 the Enhanced Surveillance system was introduced in England and Wales and in the following year in Northern Ireland. The number of cases of TB rose steadily from 6686 in 2000 to a peak of 8919 cases reported in 2011 after which the numbers started to decline. The overall UK rate in 2017 was reported as 8.4/100,000 down from 14.1/100,000 in 2011. England had the highest rate 9.2/100,000 and Wales the lowest 3.4/100,000. Despite the overall the drop since 2011 England continues to have one of the highest TB rates in Western Europe [68].

Data collected throughout England averaged over a 3 year period of 2015–2017 show that London, Manchester and Birmingham have the highest rates (24.3, 23.4 and 22.8 per 100,000 population respectively). This has been attributed to its highly mobile population, the variety of ethnic groups, a high prevalence of HIV, and the emergence of drug-resistant strains.

A similar picture was initially found in the USA, when there was a reversal of a long-standing downward trend in 1985. However, between 1986 and 1992, the number of cases increased from 22,201 to 26,673 [69]. There were also serious outbreaks of multi-drug-resistant TB (MDR-TB) in hospitals in New York City and Miami [70]. Factors pertinent to the overall upswing included the emergence of HIV, the increasing numbers of immigrants from countries with a high prevalence of tuberculosis, and perhaps more significantly, the stopping of categorical federal funding for control activities in 1972. The latter led to a failure of the public health infrastructure for TB control. Since 1992, the trend has reversed as the CDC transferred most of its funds to tuberculosis surveillance and treatment programs in states and large cities. In 2017 9093 cases were reported to the CDC giving an overall TB rate of 2.8 cases/100,000 persons. More than 50% of all TB was reported in four states (California, Florida, New York and Texas). The TB rate was 14.6 times higher in non US born persons than in US born persons and although this represented a decrease in previous years there was only a 0.9% decrease in the non US born persons compared with 7% in those born in the USA. The HIV status was known for 86% of all TB cases reported in 2107 and 5.6% were shown to be co infected with HIV [71].

The acquisition of tuberculosis infection is not necessarily followed by disease as the infection may heal spontaneously. It may take weeks or months before disease becomes apparent or infection may remain dormant for years before reactivation in later life especially if the person becomes debilitated or immunocompromised. Contrary to popular belief, the majority of cases of TB in immunocompetent people pass unnoticed. Of reported cases, 75% involve the lung, while non-respiratory (e.g. bone, heart, kidney, brain) or dissemination (miliary TB) are more common in immigrant ethnic groups and the immunocompromised [72]. They are also more likely to develop resistant strains. In the general population, there is an estimated 10% lifetime risk of tuberculosis infection progressing to disease [73].

In 2017 there were a total of 464,633 cases reported of TB in people living with HIV. This represents 51% of the estimated number of cases indicating the degree of under reporting. This is very significant as TB is more likely to progress to active TB in HIV positive individuals with a greater than 50% lifetime risk [74]. TB can also lead to a worsening of HIV with an increase in viral load [75]. Therefore, the need for early diagnosis is paramount but it can be more difficult as pulmonary TB may present with non-specific features, e.g. bilateral, unilateral or lower lobe shadowing [76].

Symptoms of Pulmonary TB

After an incubation of 4–12 weeks, symptoms may develop (see Table 10.7).

Routes of Transmission

The main route is airborne through infected droplets, but prolonged or close contact is needed. Non-respiratory disease is not considered a risk unless the *Mycobacterium* is aerosolized under exceptional circumstances (e.g. during surgery) or there are open abscesses.

Table 10.7 Symptoms of pulmonary TB

Cough lasting >3 weeks or >2 weeks in endemic countries
Fatigue
Anorexia and weight loss
Fever and night sweats
Mild haemoptysis (rusty colored)
Cough with phlegm
Swollen lymph glands

Period of Infectivity

A person is considered infectious as long as viable bacilli are found in induced sputum. Untreated or incompletely treated people may be intermittently sputum-positive for years.

Following 2 weeks of appropriate treatment, the individual is usually considered as non-infectious. This period may be extended for treatment of MDR-TB or XDR-TB or for those with concomitant HIV. Patient compliance also plays an important factor.

At-Risk Groups

The risk of infection is directly proportional to the degree of exposure. More severe disease occurs in the malnourished, or the immunocompromised (e.g. HIV etc.) and substance misusers.

Immunocompromised people are at special risk of MDR-TB, XDR-TB or *Mycobacterium avium-intracellulare* (MAI) although more recently cases resistant to treatment have been described in immunocompetent people.

Management in Custody

Staff with disease should stay off work for 2 weeks whilst treatment is taking effect. You no longer have to wait to be sputum negative as the bacilli can persist for months even though you are no longer infectious. Staff in contact with disease who have been vaccinated with BCG are at low risk of acquiring disease, but should minimize the time spent in the cell. Those who have not received BCG or who are immunocompromised should avoid contact with the detainee wherever possible. Any staff member who is pregnant, regardless of BCG status or type of TB, should avoid contact all together.

Anyone who has had a significant exposure should report to Occupational Health or their GP if no other route exists for testing and treatment if needed. They should also be educated as to the symptoms of TB. Anyone who is likely to come into repeated contact with individuals at risk of TB should receive BCG (if they have not already done so) regardless of age, even though there is evidence to suggest that BCG administered in adult life is less effective. This does not apply to immunocompromised individuals or pregnant women. In the latter case, vaccination should preferably be deferred until after delivery. HIV positive people should never be given BCG.

Detainees with disease (whether suspected or diagnosed) who have not been treated or treatment is incomplete (i.e. less than 2 weeks) should be kept in custody for the minimum time possible. Immunocompromised individuals with TB are usually too ill to be detained, but if they are, they should be considered at greater risk of transmitting disease to staff. Any detainee with disease should be encouraged to cover their mouth and nose when coughing and sneezing.

Staff should wear gloves when in contact with the detainee and when handling clothing and bedding. Any bedding should be bagged after use and laundered or incinerated. The cell should be deemed out of action until it has been ventilated and professionally decontaminated, although there is no hard evidence to support that there is a risk of transmission from this route.

Severe Acute Respiratory Syndrome SARS-CoV and Middle East Respiratory Syndrome MERS-CoV

On March 142,003, the WHO issued a global warning to health authorities about a new atypical pneumonia called SARS. The earliest case was believed to have originated in the Guandong province of China on 16 November 2002. The causative agent was identified as a new Corona virus—SARS-CoV [77, 78]. By the end of June 2003, 8422 cases had been reported from 31 different countries with a total of 916 deaths. Approximately 92% of cases occurred in China (including Hong Kong, Taiwan and Macao). The case fatality rate varied from <1% in people less than 24 years old, to over 50% in persons 65 or older. On 5 July 2003, the WHO reported that the last human chain of transmission of SARS had been broken and lifted the ban from all countries. However, they warned that everyone should remain vigilant, as resurgence of SARS was still a possibility and this indeed proved the case with reports ongoing until May 2004. Since then, there have been no further reported cases. Knowledge about the epidemiology and ecology of SARS-CoV and the disease remains limited; however, the experience gained from the previous outbreak enabled the disease to be contained rapidly—reflected in the few cases reported since December. There is still no specific treatment or preventative vaccine that has been developed to date.

Another coronavirus, MERS-CoV was identified in Saudi Arabia in 2012 which causes a similar clinical picture to SARS. This zoonotic disease is acquired by humans through direct or indirect contact with dromedary camels. Since 2012 27 countries have reported cases of MERS including Algeria, Austria, Bahrain, China, Egypt, France, Germany, Italy, Jordan, Malaysia, the Netherlands, Oman, Philippines, Qatar, Saudi Arabia, Thailand, Tunisia, Turkey the UK, the USA and Yemen. Over 90% of all reported cases have been from the Kingdom of Saudi Arabia. Cases outside the Middle East have originated in travellers to that area. There was one large outbreak in the Republic of Korea with 186 cases reported Approximately 35% of patients with MERS have died but this may be an overestimate as milder cases that are not being reported are not included. As of the 3rd September 2018 2241 cases of MERS-CoV have been reported to WHO with at least 795 deaths [79].

PHE reported a laboratory confirmed case in August 2018 from a resident of the Middle East who had travelled to the UK. The last case reported from the UK was in 2013. The risk of infection to UK residents remains very low but HCPs should remain vigilant. It is important that any suspected cases are identified early and reported to local health protection teams as soon as possible.

Incubation Period and Symptoms

The incubation period for SARS is around 3–6 days (maximum 10 days), and for MERS-CoV 2–14 days with a median of 5 days.

The following clinical case definition of SARS has been developed for public health purposes [80].

A person with a history of:

- Fever (at least 38 °C)
- And, one or more symptoms of lower respiratory tract illness (cough, difficulty in breathing, dyspnea)
- And, radiographic evidence of lung infiltrates consistent with pneumonia or Respiratory Distress Syndrome, or post mortem findings of the above with no identifiable cause
- And, no alternative diagnosis can fully explain the illness.

The clinical symptoms of MERS-CoV ranges from asymptomatic or mild respiratory symptoms to severe acute respiratory disease and death. Pneumonia is common and gastrointestinal symptoms including diarrhea have also been reported. Severe cases require hospitalization and mechanical ventilation. More severe disease occurs in older people, those who are immunosuppressed or who have chronic diseases such as cancer, renal disease, diabetes and other chronic lung diseases. The algorithm for possible cases of MERS-CoV can be found at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732267/Algorithm_case_v31-Aug2018.pdf.

Route of Transmission

SARS is spread by close contact with an infected individual via aerosol or infected droplets. Most cases occurred in hospital workers caring for an index case or their close family members. The virus can also be spread by hands and other objects the droplets have touched. The virus has also been shown to survive in stool for up to 4 days.

For MERS-CoV the route is thought to be from dromedary camels to humans but is not fully understood. Human to human transmission does not occur easily but clusters of cases have occurred in healthcare facilities where infection control practices have been poor. No sustained human to human transmission of MERS-CoV has been documented anywhere in the world [81].

Management in Custody

There have been no cases of SARS since 2004, but cases of MERS-CoV do continue to occur so should be borne in mind for returning travelers who present with respiratory symptoms. There is no vaccine or medicine specific for MERS-CoV so treatment is just supportive and is based on the clinical condition of the patient.

Infections Transmitted Through the Faecal-Oral Route

General Considerations

The most consistent feature of diseases transmitted through the fecal-oral route is diarrhea (see Table 10.8). Infective agents include bacteria, viruses and protozoa.

Table 10.8 Common causes of infective diarrhea

Cause	Symptoms	Incubation	Infectivity	Notes
Campylobacter	C, F, N, V, BD	1–10 days	Untreated—7 weeks	Requires antibiotics. Seek advice. Exclude from custody in acute phase
E coli 0157:H7	BD rarely WD, F is rare	3–8 days	Up to 48 h after diarrhea and vomiting stops around 7 days	Person to person spread. Can be serious with TTP HUS, dehydration, seek advice. Antibiotics not usually used as can increase risk of HUS and increase toxin production
Norwalk Virus	N, V, D, AP, F	24–72 h	Up to 48 h after diarrhea stops	Mild to moderate self-limiting
Rotavirus	F, V, WD ± AP	24–72 h	Up to 8 days but up to 30 days in immunocompromised	Symptomatic treatment. Persists in environment
Salmonella	H, AP, D, N, F ± V	6–72 h	Days to weeks	Persistent carriage can occur. Requires antibiotics. Seek advice
Shigella	DY/WD, F, N, (C, V)	12–96 h	Up to 4 weeks	Usually mild but can be severe in IC. Needs antibiotics Seek advice

AP abdominal pain, *H* headache, *BD* bloody diarrhea, *HUS* hemolytic-uremic syndrome, *C* cramps, *IC* immunocompromised, *D* diarrhea, *N* nausea, *DY* dysentery (blood and mucus), *TTP* thrombotic thrombocytopenic purpura, *F* fever, *V* vomiting, *WD* watery diarrhea

Since the causes are numerous, it is beyond the remit of this chapter to cover them all. It is safest to treat all diarrhea as infectious unless the detainee has a proven non-infectious cause (e.g. Crohn's disease, ulcerative colitis).

All staff should wear gloves when in contact with the detainee or handling clothing, bedding etc. and contaminated articles should be laundered or incinerated. The cell should be professionally cleaned after use paying particular attention to the toilet area.

Hepatitis A

Epidemiology and Prevalence

This viral hepatitis occurs worldwide with variable prevalence. It is highest in countries where hygiene is poor and infection occurs all year round. In temperate climates, the peak incidence is in autumn and winter, but the trend is becoming less marked.

All age groups are susceptible if they are non-immune or have not been vaccinated. In developing countries, the disease occurs in early childhood, whereas the reverse is true in countries where the standard of living is higher.

In the UK, there has been a gradual decrease in the number of reported cases from 1990 to 2000 [82, 83]. This is due in part to improved standards of living and the introduction of an effective vaccine. In 2015 there were 330 confirmed cases of hepatitis A. The highest incidence occurred in the 15–34-year-old age group [84].

In the UK between July 2016 and January 2017, 37 confirmed cases of hepatitis A were reported from eight areas in England and Northern Ireland and of those 28 were identified among MSM [85]. Since 2016, 1173 confirmed cases of hepatitis A have been reported from 15 EU countries. Most cases were reported among MSM [86]. Cases in the UK and the EU have been with identical strains prompting the European Centre for Disease Prevention and Control (ECDC) to issue a rapid risk assessment in December 2016 [86]. The outbreak emphasized the need for awareness of hepatitis A among the MSM population.

Symptoms

The clinical picture ranges from asymptomatic infection through a spectrum to fulminant hepatitis. Unlike HBV and HCV, HAV does not persist or progress to chronic liver damage. Infection in childhood is often mild or asymptomatic, but in adults tends to be more severe.

Following an incubation period of 15–50 days (mean 28 days), symptomatic infection starts with the abrupt onset of jaundice anything from 2 days to 3 weeks after the anicteric phase. It lasts for approximately the same length of time and is often accompanied by a sudden onset of fever.

HAV infection can lead to hospital admission in all age groups, but is more likely with increasing age.

The overall mortality is less than 1%, but 15% of people will have a prolonged or relapsing illness over 6–9 months. Fulminant hepatitis occurs in <1% of people, but is more likely over the age of 65 or in those with pre-existing liver disease. In hospitalized patients, case fatality ranges from 2% in 50–59 year olds to nearly 13% in those older than 70 years [83].

Period of Infectivity

The individual is most infectious in the 2 weeks before the onset of jaundice when they are asymptomatic. This can make control of infection difficult since the disease is not recognized.

Routes of Transmission

The main route is fecal-oral through the ingestion of contaminated water and food. It can also be transmitted by close personal contact including homosexuals practicing anal intercourse and fellatio. There is a very slight risk from blood transfusions if the donor is in the acute phase of infection. It should not be considered a risk from needlestick injuries unless clinical suspicion of HAV is high.

Risk Groups

Risk groups include the homeless, MSM, PWID, travellers abroad who have not been vaccinated, patients with chronic liver disease and chronic infection with HBV and HCV, employees and residents in day-care centers and hostels, sewage workers, laboratory technicians and those handling non-human primates.

Several large outbreaks have occurred among injecting drug users—some with an epidemiological link to prisons [87, 88]. Transmission occurs during the viremia phase of the illness through sharing injecting equipment and via fecal-oral routes because of poor living conditions [89]. There have also been reports of HAV being transmitted through drugs that have been carried in the rectum. A study in Vancouver showed that 40% of injecting drug users had past infection of HAV and they also showed an increased prevalence among men who have sex with men [90].

Management in Custody

Staff with disease should report to Occupational Health and stay off work until the end of the infective period. Those in contact with disease (either through exposure at home or from an infected detainee) should receive prophylactic treatment as soon as possible (see below).

To minimize the risk of acquiring disease in custody, staff should wear gloves when dealing with the detainee then wash their hands thoroughly. Gloves should only be disposed of in the clinical waste bags.

Detainees with disease should be kept in custody for the minimum time possible. They should only be sent to hospital if fulminant hepatitis is suspected. The cell should be quarantined after use and professionally cleaned. Any bedding or clothing should be handled with gloves and laundered or incinerated according to local policy. Detainees reporting contact with disease should be given prophylactic treatment as soon as possible (see section "Post exposure prophylaxis").

Post exposure Prophylaxis

Contacts of HAV should receive HAV vaccine (e.g. Havrix Monodose or Avaxim) if they have not been previously immunized or had disease. Human normal immunoglobulin (HNIG) 500 mg deep im in gluteal muscle should be used in the following circumstances:

- The contact is aged 60 or over and it is within 14 days of exposure
- Also for close contacts within 14 days of exposure who are HIV positive and have a CD4 count <200 cells/mm^3
- For contacts who are immunosuppressed for other reasons within 14 days of exposure.

If time allows anyone needing HNIG should be tested for IgG antibodies to hepatitis A (anti-HAV IgG) [91].

Staff at higher risk of coming in contact with HAV should consider being vaccinated prior to exposure. Two doses of vaccine given 6–12 months apart provide around 25 years of protection. There is no specific treatment for HAV except supportive measures and symptomatic treatment.

Exotica

Although the chance of encountering a tropical disease in custody is small, it is worth bearing in mind. It is not necessary for a healthcare professional to be able to diagnose the specific disease, but simply to recognize that the detainee/staff member is ill and whether or not they need to be sent to hospital. This is best achieved by knowing the right questions to ask and carry out the appropriate examination. Tables 10.9, 10.10, and 10.11 should be used as an aide memoire in order not to miss some more unusual diseases.

Illustrative Cases 1. A police officer sustained a needle stick injury whilst searching a detainee's property. The needle penetrated his gloves and drew blood. The officer reported the injury immediately to the HCP who encouraged the puncture to bleed and washed the area well with soap and water and applied a plaster.

Table 10.9 Suspicion of exotica? History and examination aide memoire

Has the detainee travelled to Africa, South East Asia, the Indian Sub-continent, Central/South America or the Far East in the last 6–12 months
Ascertain whether they received any vaccinations prior to travel and what
Ask if they took malaria prophylaxis, what type and whether they completed the course
Ask if they swam in any stagnant lakes during the trip
If yes to any of the above, ask if they have experienced any of the following symptoms:
A fever/hot or cold flushes/shivering
Diarrhea ± abdominal cramps ± blood or slime in the stool
A rash
Persistent headaches ± light sensitivity
Nausea or vomiting
Aching muscles/joints
A persistent cough (dry or productive) lasting at least 3 weeks

Table 10.10 Examples of tropical diseases that present with a fever

Disease	Countries	Incubation	How transmitted	Management
Dengue	Caribbean and S. America, Asia, Africa	3–14 days	Mosquito—no human to human in the UK	Usually symptomatic
Ebola	Sub Saharan Africa	2–21 days	Body fluids from infected people	Isolation and hospitalisation
HFRS[a]—Hanta virus	Europe, Asia, Africa	2 days to 8 weeks	Rat, mouse and vole excreta and body fluids	Hospital
HPS[b]—Hanta virus	North and South America	2 days to 8 weeks	Rat, mouse and vole excreta and body fluids	Hospital
Lassa fever	West Africa	6–21 days	Rat urine and excreta	Isolation and Hospitalisation
Malaria	Sub Saharan Africa, some parts of Asia and South America, Vanuatu	7 days to 1 year	Mosquito—no human to human transmission in the UK	May need urgent treatment
Yellow fever	Sub Saharan Africa and South America	3–6 days	Mosquito—no human to human transmission in the UK	Often needs hospital treatment

[a]*HFRS* haemorrhagic fever with renal syndrome
[b]*HPS* hantavirus pulmonary syndrome

Details of the incident were recorded along with a medical history of the police officer and details of vaccinations received. The police officer reported that he had not had any hepatitis B vaccine. He had no underlying health concerns.

The HCP spoke with the detainee who admitted injecting drugs and to sharing needles. He last shared a needle more than 3 months ago and had no other risk fac-

Table 10.11 Examples of tropical diseases that can present with diarrhoea

Disease	Incubation	Infectivity	Transmission route	Management
Amoebic dysentery	Days to months	Years	Oral-fecal	Anti-parasitic treatment e.g. metronidazole
Cholera	Hours to 5 days	3–5 days after recovery	Oral-fecal Vomit	Requires antibiotics
Gardia	3–25 days	Months	Oral-fecal	Anti-parasitic treatment e.g. tinidazole
Malaria	7 days to 1 year	None	None	Urgent treatment—hospital
Typhoid[a]	Up to 3 days	Days to weeks	Oral-fecal	Requires antibiotics

[a]Typhoid can also present as a fever

tors. The HCP asked if the detainee was willing to provide a sample of blood which would be tested for hepatitis B, HIV and hepatitis C. The detainee agreed and signed a consent form which was countersigned by the HCP and an independent police officer. Ten mLs of clotted blood was taken from the detainee which was given to the police officer involved who took it to the designated hospital. A 10 mL clotted sample of blood was taken at the hospital from the police officer as a baseline blood to be stored.

Testing of the detainee's blood revealed the following:

HBs Ag positive
HCV antibody positive
HIV antibody/Ag negative

Based on these findings and the unvaccinated status of the police officer—HBIG was administered into the gluteal region along with the hepatitis B vaccination in to the deltoid region. Arrangements were made to follow up the police officer to receive two further doses of hepatitis B vaccine at 4 and 8 weeks. Further screening for hepatitis C RNA at 6 and 12 weeks and for HCV antibodies at 12 and 24 weeks. A test for HBsAg would also be conducted at 24 weeks.

2. A detainee was arrested and brought into custody. Whilst filling in the risk assessment form the Custody Sergeant became aware that the detainee was on medication for pulmonary TB.

   The HCP was asked to examine the detainee and established that the diagnosis of TB had been made 3 weeks ago.

   The detainee had been prescribed isoniazid and rifampicin for 6 months with ethambutol and pyrazinide for the first 2 months. She reported that she had taken her medication every day for the last 20 days. This was evidenced by the number of tablets that had gone from the supply given. She said that she was feeling less tired and was no longer getting night sweats.

The HCP concluded that with such good compliance the detainee was unlikely to be infectious now and was therefore safe to remain in custody.

Key Points

- The aim of adopting standard precautions with all personnel is to prevent transmission of BBVs by considering that blood and other body fluids are potentially infectious.
- The vulnerable population of patients seen in police custody are at risk of a number of infections due to general poor health, intravenous drug use, and social circumstances. There needs to a high index of suspicion and careful consideration as to whether treatment is required, including referral to hospital.

Self-Assessment Exercises

1. Place these hepatitis B markers in order of infectivity starting with the least infectious and give the % chance of acquisition of hepatitis B following a needle stick injury for each:
   HBsAg, HBeA, HBeAg, HBSA
2. When is the earliest time for detecting (a) antibodies, (b) RNA following infection with hepatitis C virus?
3. (a) What is the current recommended regime for PEP in the UK?
   (b) How long after exposure can PEP be considered?
4. When would you send a detainee or staff member with chicken pox to hospital? Give at least two examples
5. What are the main criteria for giving prophylactic antibiotics following human and other animal bites? Name the first choice of antibiotic and an alternative for people with allergies to penicillin.

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Fitness to Be Interviewed and Fitness to Be Charged

11

Margaret M. Stark and Keith J. B. Rix

Learning Objectives
Explain the different types of false confessions.

Be able to describe the various conditions, both physical and mental, that might result in vulnerability.

Explain how to evaluate whether a detainee might be at risk during a police interview.

Introduction

The interview of suspects or persons of interest is an essential component of all systems of criminal investigation. Codes C of the Codes of Practice of the Police and Criminal Evidence Act 1984 (PACE) [1] and the Police and Criminal Evidence (Northern Ireland) Order 1989 (PACE(NI)O) [2] define an interview as:

> *'the questioning of a person regarding their involvement or suspected involvement in a criminal offence or offences which […] must be carried out under caution'*. (Code C 11.1A)

Section 82 (1) PACE defines a confession as including any statement wholly or partly adverse to the person who made it.

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The confessions and other incriminating statements that are obtained during interviews have always played an important role in prosecutions and continue to be relied on as evidence of guilt in a substantial number of trials. For example, in England and Wales, confessions have been found to provide the single, most important piece of evidence against defendants in the Crown Court, being crucial in about 30% of cases [3]. Similarly, an influential American observational study found that interview was necessary for solving the crime in about 17% of cases [4]. Whereas in Scotland corroboration of a suspect's confession has always been required; other than in exceptional cases there is a need for two separate sources of evidence before a case comes to trial. The quest to obtain confessions from the mouths of suspects has seen a slow and uneven move away from the inquisitions aided by torture and oppression of the Middle Ages toward the doctrine that:

> *A free and voluntary confession is deserving of the highest credit, because it is presumed to flow from the strongest sense of guilt and therefore it is admitted as proof of the crime to which it refers; but a confession forced from the mind by the flattery of hope or by the torture of fear comes in so questionable a shape when it is to be considered as the evidence of guilt, that no credit ought to be given to it; and therefore it is rejected* [5].

In the years since this judgment, considerable effort has been expended on attempting to regulate the custodial interview in order to minimize the risk of false confessions while preserving the value of interrogation as a means of solving crime. In this section, we will consider the important psychological aspects of interview and confession and then discuss the role the healthcare professional (HCP) can play in ensuring that suspects are fit to be interviewed.

Police Interview Techniques

A number of American manuals detail the way in which coercive and manipulative interrogation techniques can be employed by police officers to obtain a confession [6, 7], with similar techniques being advocated by Walkley [8] in the first such manual written for British officers. The authors of these manuals propound various highly effective methods for breaking down a suspect's resistance while justifying a certain amount of pressure, deception, persuasion, and manipulation as necessary in order for the "truth" to be revealed. Walkley acknowledges that "if an interviewer wrongly assesses the truth-teller as a lie-teller he may subject that suspect to questioning of a type which induces a false confession." Generally, however, the manuals pay scant attention to the fact that, in certain circumstances, the techniques they recommend may make a suspect confess to a crime he or she did not commit and there is now a considerable body of experimental evidence that raises serious concerns about the use of such techniques [9]. Manipulative and persuasive tactics continued to be used in England and Wales, particularly in relation to more serious crimes, at least until the late 1980s and early 1990s [10–12].

Interviewers are encouraged to look for verbal clues, nonverbal clues and behavioural attitudes which indicate deception. However, the innocent as well as the guilty may exhibit signs of nervousness. Innocent suspects may be anxious because they are erroneously being accused of being guilty, because of worries about what is going to happen to them while in custody, and possibly because of concerns that the police may discover some previous transgression. Furthermore, there are three aspects of a police interview that are likely to be as stressful to the innocent as to the guilty: the stress caused by the physical environment in the police station, the stress of being isolated from family and friends, and the stress caused by the suspect's submission to authority. All these factors can markedly impair the performance of a suspect during interview. Indeed, American research has suggested that for most suspects interviews are likely to be so stressful as to impair their judgement on such crucial matters as the exercise of legal rights [13]. Furthermore in an experimental study comparing forensic investigators and students, although the investigators were better than students in distinguishing between true and false denials, they were significantly more likely to make false positive errors suggesting a bias towards perceiving deception where there is none [14]. As observed by Vrij [15] '*once innocent suspects are mistakenly identified as guilty, they run the risk of being submitted to an interview style that is even more grilling than the interview style that guilty suspects are subjected to*.' It is little wonder that false confessions are made to the police.

False Confessions

During the last two decades of the twentieth century, the United Kingdom (UK) witnessed a number of well-publicized miscarriages of justice in which the convictions depended heavily on admissions and confessions made to the police that were subsequently shown to be untrue [16–18]. In reviewing 70 earlier wrongful imprisonments that occurred between the years 1950 and 1970, Brandon and Davies [19] found that false confessions were second only to incorrect identification evidence as the most common cause of wrongful conviction. In 1994, Justice [20] identified 89 cases in which an alleged miscarriage of justice rested on a disputed confession. There has been no comparable research this century in the UK but the number of such cases considered by the Criminal Division of the Court of Appeal of England and Wales suggests that such miscarriages of justice are now less frequent. This is probably a result of the bedding down of PACE with its Code of Practice and the increasing use of the PEACE (Planning and Preparation; Engage and Explain; Account clarification and challenge; Closure; Evaluation) model of interviewing [21] which has formed part of a national training package for police officers since 1993 along with the influential of work of forensic psychologist and former Icelandic police officer Gisli Gudjonsson [9] which has led to what has been described as improved professionalism in investigative interviewing [22].

Gudjonsson [23] has reviewed 34 cases of miscarriages of justice between 1989 and 2009 and found that in 23 cases (68%) the conviction was overturned on the basis of a psychological vulnerability identified, including borderline IQ, personality disorder, clinical depression, pathological attention seeking, abnormal traits of suggestibility and or compliance. In only 10 cases (29%) were there police/procedural improprieties.

However, a review of key USA studies in [24] found that the percentage of false confessions in studies of wrongful convictions ranged from 14% to 25%. Since then there has been a singularly important study [25] of DNA exoneration cases which found that 16% of those exonerated had given detailed narratives of the crime, most of them richly contaminated accounts which were '*so persuasive, detailed, and believable that judges repeatedly upheld the convictions during appeals and habeas review*'.

Therefore vigilance must remain the watchword. People are at risk of making false and misleading admissions against their own interest. We need to turn to modern psychology to obtain insights into why this happens and to learn how it can be avoided.

Why Make a False Confession?

There is no single reason why people falsely confess to crimes they have not committed. Indeed, such confessions usually result from a combination of factors unique to the individual case. Nonetheless, Kassin and Wrightsman [26] have been able to identify three distinct types of false confession, which have been developed by Gudjonsson [27] and Shepherd [28]. These categories are voluntary, accommodating-compliant, coerced-compliant, coerced-reactive and coerced-internalized.

Voluntary False Confessions

Voluntary false confessions are offered by individuals without any external pressure from the police. Commonly the individuals go voluntarily to the police to confess to a crime they may have read about in the press or seen reported on television. Often they do so out of a morbid desire for notoriety, the individual seeming to have a pathologic desire to become infamous, even at the risk of facing possible imprisonment.

Alternatively, a voluntary false confession may result from the individual's unconscious need to expiate guilt feelings through receiving punishment. The guilt may result from real or imagined past transgressions or, occasionally, may be part of the constant feeling of guilt felt by some individuals with a poor self-image and high levels of trait anxiety.

By contrast, some people making this type of confession do so because they are unable to distinguish between fact and fantasy. Such individuals are unable to differentiate between real events and events that originate in their thinking, imagination, or planning. Such a breakdown in reality monitoring is normally associated with psychotic illness, such as schizophrenia.

On occasions, people may volunteer a false confession to assist or protect the real culprit. Gudjonsson [29] highlights some evidence that confessing to crimes to protect others might be particularly common in juvenile delinquents.

Finally, Shepherd [28] identifies a subset of individuals who falsely confess to crimes to preempt further investigation of a more serious crime.

Accommodating-Compliant False Confessions

Expanding on the original three distinct categories of false confession, Shepherd [28] recognizes a group of people for whom acquiescing with the police is more important than contradicting police assertions about what happened. In such circumstances a false confession arises from a strong need for approval and to be liked. Police conduct is noncoercive, although it does involve the use of leading questions sufficiently obvious to suggest to the suspect what answers the police want to hear. People at all intellectual levels are at risk of behaving in this manner, with those who are excessively compliant being at greatest risk.

Coerced-Compliant (or Pressured-Compliant) False Confessions

Coerced-compliant false confessions are typically elicited during persuasive interrogation: the person perceives that there is some immediate instrumental gain from confessing. The suspect does not confess voluntarily but comes to give in to the demands and pressures of the interrogators. He or she is fully aware of not having committed the crime of which he is accused, and the confession is usually retracted once the immediate threat is over. The key mechanism is dysfunctional/maladaptive coping [30].

Gudjonsson [31] suggests that the four main types of perceived immediate gain are being allowed home after confessing, bringing the interview to an end, a means of coping with the demand characteristics (including the perceived pressure) of the situation, and avoidance of being locked up in police custody. Recognizing that not all police-induced false confessions are coerced [32] and that coercion can occur from other sources than the police [33] (see below), Gudjonsson [34] now suggests that the word ‘coerced’, which is a legal concept, should be replaced by ‘pressured’.

In these circumstances the suspect may be vaguely or fully aware of the consequences of making a false self-incriminating statement, but the perceived immediate gain outweighs, in their mind, the potential long-term consequences. They may think that their innocence will be self-evident and naively believe that the truth will come out later in court, perpetuating the belief shared by many police officers and legal advisers that what happens in the police station is not really that important.

Coerced-Reactive (or Pressured-Reactive) False Confessions

Gudjonsson [34] now recognizes a type of false confession that results from pressure by persons other than police officers such as family, friends and peers. This hitherto previously neglected group of false confessors has been identified by

McCann [33] who suggests that as this type is likely to involve a close emotional relationship between the false confessor and the coercer it should be conceptualized separately from police coerced confession. The assumption that the relationship produces an additional pressure on the coerced person receives support from research [35] which suggested an overlap in vulnerability to compliance in personal and impersonal relationships. In such cases a refusal to comply with a request from a close friend or partner may result in a fear of emotional rejection or, if it is an abusive relationship, a fear of violence.

Coerced-Internalized (Pressured-Internalized) False Confessions

Coerced-internalized false confessions occur when suspects are gradually persuaded that they have committed a crime of which they have no recollection, or when they have become so confused that they begin to mistrust their own memory ('memory distrust') and accept a false scenario suggested by the police. In order to achieve this, the investigator has to convince the suspect that (a) there is incontrovertible evidence that they committed the crime of which they are accused, even though they have no recollection of it, and (b) there is a good and valid explanation for their having no recollection of it. This type of confession can happen under two distinct conditions:

1. The suspects have no memory of the alleged offense, even whether or not they committed it. This can be as a result of amnesia such as alcohol-amnesia. In essence, the suspects have no clear recollection of what they were doing at the time the offense was committed and come to believe they must have committed the crime.
2. At the outset of the interview, the suspects have a clear recollection that they were not involved in the alleged offense. However, as a result of subtle manipulative techniques employed by the interrogator, they begin to distrust their own memory and beliefs. Interrogators attempt to undermine the suspects' confidence in their own recollection of events, which then creates sufficient self-doubt and confusion to cause them to adjust their perceptions of reality and accept the allegations put by the police. To make matters worse, the original memory contents may then be inaccessible.

In contrast to the makers of coerced-compliant false confessions, those who make coerced-internalized false confessions only come to retract when they realize, or suspect, that they are in fact innocent. These retractions can take considerable time and, on occasion, may never occur if the original memory of events becomes permanently distorted.

A key component facilitating internalization is susceptibility [36]. This can be dispositional such as naivety, low IQ, or suggestibility, or transient factors associated with custody and interrogation such as social isolation, extreme stress or sleep deprivation. Gudjonsson [37] further identifies as pre-existing vulnerabilities for internalized false confessions: substance misuse, memory problems and lack of confidence in memory which cause suspects to doubt their existing memory of innocence. These same vulnerabilities, which along with poor self-image/low self-esteem, suggestibility, compliance and tendency towards confabulation, can create the false belief of guilt ('plausibility acceptance') and then assist the suspect with a reconstruction based on suggested material using crime-related knowledge and imagined material and using leading and hypothetical questions.

Suggestibility, Compliance and Acquiescence

Of vital importance to an understanding of why false confessions can often prove so incriminating is an awareness of the theory of interrogative suggestibility [38, 39]. At the heart of the theory is the way leading questions can produce distorted responses from suspects because they are phrased in such a way as to suggest the expected response. Through this process people can come to accept a piece of post-event information and incorporate it into their memory, thus appearing to have "special knowledge" about the alleged offense. This special knowledge may seriously mislead the police and the courts to assume the suspect's guilt erroneously. Suggestibility has been found to be moderated by factors such as anxiety, poor memory, history of life adversity, poor self-esteem, and low intelligence [40]. These factors impair the suspect's ability to cope with the uncertainty and expectations contained within questioning.

Compliance refers to the tendency of people to obey the instructions of others when they don't really want to, either because they are overeager to please or are simply unable to resist the pressure [41]. The traits of both suggestibility and compliance have been shown to be relevant to the issue of false confessions [42].

Acquiescence is the manner by which people answer questions in the affirmative irrespective of content. Acquiescence is more highly correlated with low intelligence than suggestibility or compliance [40].

Preventing False or Otherwise Unreliable Confessions

It is a fundamental tenet of both American and English law that reliance should only be placed on confession evidence that is given freely and voluntarily. In considering the voluntary nature of a confession, several factors will need to be considered. These include the vulnerability of the accused (as a result of factors such as age, mental illness, intellectual disability, physical illness or injury, intoxication with alcohol or other substances, memory problems, suggestibility, compliance), the conditions of detention (lack of access to legal advice, failure to be given legal rights, adequate rest periods during detention, solitary confinement, lack of social support, continued interrogation over a long period of time, physical violence by the police), and the characteristics of the interrogation (pressure, manipulation, threats, physical abuse, inducements etc.).

In America the most important legal development designed to protect the rights of suspects and deter police misconduct relates to the case of Miranda v Arizona, which was decided in 1966 [43]. The effect of this judgment was to ensure that all criminal suspects in police custody must be warned against self-incrimination and made aware of their right to remain silent and to receive legal advice. These rights have to be actively waived by the accused before interrogation can commence, and any violations of the requirements render any subsequent confession inadmissible.

In England and Wales and in Northern Ireland, statutory safeguards are provided by PACE and the PACE(NI)O respectively and their Codes of Practice [1, 2], which regulate practice in respect to a number of matters including the detention, treatment, and questioning of persons by police officers.

Specifically s 76 of PACE deals with the challenges to the admissibility of confessions in criminal proceedings. Under s 76(2) the court shall not allow a confession to be admitted if it was or may have been obtained:

(a) by oppression

(b) in consequence of anything said or done which was likely … to render unreliable any confession which might be made by him in consequence thereof.

Section 78(1) of PACE states that the court may refuse to allow confession evidence if it appears that:

> *"having regard to all the circumstances, including the circumstances in which the evidence was obtained, the admission of the evidence would have such an adverse effect on the fairness of the proceedings that the court ought not to admit it."*

The fairness of the trial proceedings in criminal cases is guaranteed by Article 6 of the European Convention on Human Rights. Confessions will generally be inadmissible if the provisions of the Codes of Practice are breached by the police [44, 45].

The role of the HCP when assessing a suspect's fitness for interview is seen as fitting into this overall legal framework. The HCP's primary concern being to recognize any characteristics that might render the individual vulnerable to providing a false or otherwise unreliable confession so that adequate safeguards can be put in place.

A Definition of Fit for Interview

Previously there was no clear definition of what precisely is meant by the term "fit to be interviewed," which has led to confusion among those doctors called on to perform these assessments [46]. To address this deficiency Norfolk [47] proposed a definition that was used as the starting point for discussion by a subgroup set up by the Home Office Working Party on Police Surgeons in the UK. That working party made an interim recommendation [48], which has now been modified and included since 2003 in the PACE Codes of Practice [42], thus providing the first Parliamentary approved definition of the term fitness for interview. The Codes of Practice state that:

A detainee may be at risk in an interview if it is considered that:

(a) Conducting the interview could significantly harm the detainee's physical or mental state.
(b) Anything the detainees say in the interview about their involvement or suspected involvement in the offence about which they are being interviewed might be considered unreliable in subsequent court proceedings because of their physical or mental state.

Thus, a suspect with known ischemic heart disease who is experiencing chest pain satisfies the criteria of (a) above and clearly needs assessment and appropriate treatment before it is safe to conduct an interrogation.

In Scotland equivalent safeguards derive from Lord Hodge's ruling in *HM Advocate v Duncan and Stewart* [2006] HCJ 06:

> '*the test is one of fairness in all the circumstances, having regard not only to the means by which the interview was conducted but also other circumstances which might place the accused in a position of such disadvantage that he could understand neither the situation he was in nor his right not to answer the questions which were put to him*.'

The concept of unreliability may be harder to evaluate and will require consideration of the various vulnerability factors associated with false confessions. In making an assessment, the Codes of Practice [49] require the HCP to consider:

1. How the detainee's physical or mental state might affect their ability to understand the nature and purpose of the interview, to comprehend what is being asked, and to appreciate the significance of any answers given and make rational decisions about whether they want to say anything;
2. The extent to which the detainee's replies may be affected by their physical or mental condition rather than representing a rational and accurate explanation of their involvement in the offense;
3. How the nature of the interview, which could include particularly probing questions, might affect the detainee.

Recognizing that '*vulnerable persons are often capable of providing reliable evidence'* but *'may, without knowing or wanting to do so, be particularly prone in certain circumstances to provide information that may be unreliable, misleading or self-incriminating'* [50, 51], the England and Wales Code C includes particular provisions relating to persons who *'may be vulnerable as a result of having a mental health condition or mental disorder'* [52]. Vulnerable applies to any person who, because of a mental health condition or mental disorder [53]:

(i) May have difficulty understanding or communicating effectively about the full implications for them of any procedures and processes connected with:
    - Their arrest and detention; or (as the case may be)

- Their voluntary attendance at a police station or their presence elsewhere, for the purpose of a voluntary interview; and
- The exercise of their rights and entitlements.

(ii) Does not appear to understand the significance of what they are told, of questions they are asked or of their replies;

(iii) Appears to be particularly prone to:
- Becoming confused and unclear about their position;
- Providing unreliable, misleading or incriminating information without knowing or wishing to do so;
- Accepting or acting on suggestions from others without consciously knowing or wishing to do so; or
- Readily agreeing to suggestions or proposals without any protest or question.

Code C of PACE(NI)O makes similar provisions for those with ‘mental disorder’, as defined in s 305 of the Mental Capacity Act (Northern Ireland) 2016 as ‘any disorder or disability of the mind’, mental vulnerability or communication difficulties.

Mental vulnerability probably includes states of extreme emotion and distress [54]. This is of particular relevance because Gudjonsson et al. [55], in a study for the Royal Commission on Criminal Justice, found that a third of suspects were not in a normal mental state while in police custody due to extreme distress or mental disorder. This could impair their capacity for rational decision-making or coping effectively with interview and they have suggested that even detainees whose mental health or psychological problems do not amount to actual mental illness or mental disorder are potentially vulnerable to giving misleading or unreliable statements.

The Codes of Practice of PACE Code C 11.15 state that a juvenile (child under 18 years of age) or vulnerable person must not be interviewed regarding their involvement or suspected involvement in a criminal offence or offences, or asked to provide or sign a written statement under caution or record of interview in the absence of the appropriate adult unless certain circumstances prevail. An officer of the rank of superintendent or above must authorize such an exceptional interview. Code C of PACE(NI)O Codes has a similar provision (11.15, 11.18).

An appropriate adult means (Code C Annex E):

(i) a relative, guardian, or other person responsible for their care or custody;

(ii) someone experienced in dealing with vulnerable persons, but who is not:
  - (a) a police officer;
  - (b) employed by the police;
  - (c) under the direction or control of the chief officer of the police force;
  - (d) a person who provide services under contractual arrangements (but without being employed by the chief officer of the police force) to assist that force in relation to the discharge of its chief officers functions:
  - (e) whether or not they are on duty at the time.

(iii) failing these some other responsible adult aged 18 or over who is other than a person described above.

The role of the appropriate adult is to safeguard the rights, entitlements and welfare of the detainee. There may be a significant problem with interviewing the mentally vulnerable without support in that any evidence obtained maybe unreliable, misleading, self-incriminating, and the vulnerable person may not be sure what is in their best interests. In the case of *R v Aspinall* [56] the failure to follow the requirements to have an appropriate adult in the interview of a mentally disordered suspect meant that, despite his apparent lucidity in interview, it was unfair to admit it in evidence.

Similar legislation to PACE regarding vulnerability is found in New South Wales, Australia. The legislation in New South Wales is arguably the most extensive, compared to other States/Territories in Australia, making special provision for a range of vulnerable persons [57].

Vulnerable persons are defined in the Law Enforcement Powers and Responsibility Regulation 2016 [58] Clause 28 as:

(a) children,
(b) persons who have impaired intellectual functioning,
(c) persons who have impaired physical functioning,
(d) persons who are Aboriginal persons or Torres Strait Islanders,
(e) persons who are of non-English speaking background,

Impaired intellectual functioning is defined in the Code of Practice for CRIME (Custody, Rights, Investigations, Management and Evidence) 2012 [59] as:

- total or partial loss of a person's mental functions
- a disorder or malfunction that results in a person learning differently from a person without the disorder or malfunction
- a disorder illness or disease that affects a person's thought processes, perception of reality emotion or judgements, or that results in disturbed behaviour

Impaired physical functioning is also defined:

- total or partial loss of the person's bodily functions or part of a person's body
- the presence in the person's body of organisms causing or capable of causing disease or illness
- the malfunction, malformation or disfigurement of part of a person's body.

When a vulnerable person is identified a 'support person' and/or 'interview friend' should be contacted to provide support.

In Ireland there is a general provision under reg 3 of the Criminal Justice Act 1984 (Treatment of Persons in Garda Síochána Stations Regulations) 1987 that members of the Garda should have regard for the special needs of any detainees who may be under a ‘physical or mental disability’ and under reg 12 there is a requirement that the interview must be conducted in ‘a fair and humane manner’.

Scheme of Examination

When assessing a detainee’s fitness for interview, the traditional medical model of taking a history and then conducting an examination should be employed. As always, informed consent should be obtained and detailed and contemporaneous notes should be taken. The HCP should review the risk assessment performed by the custody staff during the booking in process, and speak to the custody sergeant, and other relevant police officers as appropriate, to obtain any relevant background information relating to the arrest and whether there are any specific concerns about the detainee. There may be relevant information from friends, family, witnesses, as well as hospital letters. Previous police and/or health computerized records may be a source of information (NSPIS/NICHE/SCR, etc.). If time and circumstances permit, it may also be helpful for the HCP to speak to such relatives, friends or professionals, e.g. the general practitioner, community mental health team, community drug team.

In recent years, following on from the Bradley report [60], Criminal Justice Liaison and Diversion (CJLD) teams are increasingly found in police custody centres and the courts [61]. These services identify people who have mental health, learning disability, substance misuse, or other vulnerabilities, when they first come into contact with the criminal justice system as suspects, defendants, or offenders. They screen, assess and refer onto other services. The CJLD practitioner may be able to provide the HCP tasked with the assessment of fitness to be interviewed information about the detainee’s current health condition and, if required, liaise with the detainee’s mental health team for further assessment and treatment, or, where required, a formal Mental Health Act assessment.

The History

As much background information as is practicable should be obtained (as outlined above) and, when possible, an indication of how long any interview is likely to take. The demand characteristics of a long interview about a suspected murder will be much greater than a short interview about a shoplifting offense.

A general medical history should be taken with enquiry made about significant illness and any prescribed and over the counter medication. The detainee should be asked whether he or she has suffered from psychiatric illness, past or present, and specific enquiry should be made about substance misuse, both alcohol and drugs. There should be questions to assess the person’s educational background, as individuals with learning difficulties can be difficult to recognize and enquiring about schooling or being in receipt of a statement of special educational needs may aid identification.

Table 11.1 Vulnerabilities to consider in the assessment of FTI

Physical vulnerability	Mental vulnerability
Medication, e.g. concern re access/pain relief	Schizophrenia
Epilepsy: post ictal state; pre-ictal aura	Bipolar disorder
Diabetes: hypoglycemia (ideally the blood glucose should be over 6 mmol/L) [63]	Psychotic episode, e.g. drug-related
Asthma	Depressive disorder (spectrum from severe to mild)
Cardiac disease	Attention deficit hyperactivity disorder (ADHD)/Attention deficit disorder (ADD)
Cerebrovascular disease	Acquired brain injury (ABI)/Dementias
Alcohol intoxication, withdrawal, delirium tremens	Alcohol dependence, Korsakoff's syndrome, Wernicke's encephalopathy
Substance misuse/dependence including intoxication or withdrawal	Substance misuse/dependence including intoxication or withdrawal
Sleep deprivation	Intellectual disability
Injuries, e.g. head injury, fractures	Post-traumatic stress disorder (PTSD)

Make sure the detainee has not been deprived of food or sleep and enquire about significant social distractions (e.g. a single parent may make a false confession in order to obtain early release from custody and a speedy reunion with his or her child). Detainees should be asked whether they have been detained before and, if so, whether they have had unpleasant experiences while in custody in the past.

The recognition of vulnerabilities (Table 11.1) is very important in the overall assessment of fitness to be interviewed. Norfolk [62] developed the acronym 'PHIT' which refers to:

- Personality factors - suggestibility, compliance, acquiescence
- Health—mental and physical (including substance misuse)
- Interview—demands and characteristics of the interview;
- Totality of the circumstances—all other relevant circumstances of the arrest and custody

The Examination

The examination should include observations on the general appearance, physical examination as appropriate, and mental state examination. A functional assessment should be performed as to whether the detainee:

(a) is aware of the reason for arrest
(b) understands the caution and can explain it
(c) understands their legal rights
   - their right to consult privately with a solicitor and that free, independent legal advice is available ('Do you need money in order to have a solicitor

help you at the police station?' 'If you don't want a solicitor to help you now, can you change your mind later?')
  - their right to have someone informed of their arrest
  - their right to consult the Codes of Practice
  - if applicable, their right to interpretation and translation and their right to communicate with their High Commission, Embassy or Consulate

(d) is capable of making a rational decision (able to choose between relevant courses of action) and of carrying out the chosen course of action.

Each examination needs to be tailored to the individual, but HCPs should be able to assess the vulnerabilities of the detainees, both physical and mental, they have been asked to examine and thus ensure that any necessary safeguards are put in place before the interview begins.

Documenting Fitness to Be Interviewed

At the conclusion of the assessment the HCP needs to advise:

- on the need for an appropriate adult (concept of vulnerability)
- whether reassessment of the person's fitness for interview is required at a later date
- whether a (further) specialist opinion may be required
- the risks of unreliability and attempt to quantify those risks (see below).

The importance of detailed contemporaneous clinical notes of the assessment will assist the HCP if required to provide a witness statement at a much later date and give evidence in the court proceedings, including at a *voir dire* (an inquiry conducted by the judge in the absence of the jury into the admissibility of an item of evidence e.g. a confession).

The Home Office Working Group [64] identified four categories of risk:

- Definite—unlikely to be fit for interview at any stage e.g. severe dementia
- Major risk—unfit at present. Needs re-assessment or review at a later stage to establish FTI, e.g. intoxication with alcohol and/or drugs
- Some risk—precautions advised e.g. presence of AA or referral for other medical or psychiatric advice e.g. schizophrenia, depression, mild intellectual disability
- No discernible risk

If, for example, a detainee with intellectual disability is to be interviewed it will be appropriate to advise the police to keep language simple, or where an individual has a mental illness advise the appropriate adult, to be ready to intervene if particular symptoms and sings of mental illness occur such as delusional material begins to be introduced [65].

Alcohol and Fitness for Interview

It is generally accepted that severe alcohol intoxication renders a suspect unfit to be interviewed. There is much less agreement, however, when it comes to deciding when somebody with mild or moderate intoxication should be considered fit to interview [46, 66]. The customary view that intellectual processes are impaired at lower blood alcohol levels than sensory or motor processes has been challenged. Indeed, the very opposite has been shown, with intellectual processes appearing to be more resistant to alcohol than sensory and motor skills [67]. Nonetheless, the effect alcohol can have on short-term memory should be borne in mind when advising the police on fitness. Research suggests that moderate quantities of alcohol impair the process of forming new memories [68]. Deterioration in performance of a task assessing short-term memory occurred at blood alcohol levels of 70 mg/100 mL in one study [69], and a significant impairment of eyewitness memory has been demonstrated at average blood alcohol levels of 100 mg/100 mL [70]. When suspects mistrust their own memory of events, they are at increased risk of providing coerced-internalized false confessions [71].

The ultimate decision regarding whether a suspect who has been drinking is fit for interview is best decided on the medical and functional assessment performed by the HCP rather than on arbitrarily defined "safe" blood alcohol levels [72].

Alcohol withdrawal states and the complications of alcohol withdrawal can impair cognitive functioning and affect both a suspect's ability to cope with interrogative pressure and the ability to provide reliable testimony. Even the after effects of alcohol, or "hangover," have been shown to impair critical task performance, such as aircraft operation, and can impair judgment [73]. Research evidence has also suggested that alcohol withdrawal can increase a suspect's suggestibility, although it is not totally clear whether this is a direct result of the alcohol withdrawal or a secondary effect of its treatment [74].

Illustrative Case *A 37 year old male had been arrested on suspicion of criminal damage of a motor vehicle. The police had performed a risk assessment and established that the detainee was under the influence of alcohol and there was a query that he had received brain damage a couple of months prior to this arrest. The detainee had been seen by a colleague after arrest who had concluded that the detainee was intoxicated with alcohol. The HCP was now asked to assess whether the detainee required an appropriate adult.*

The detainee gave a history of drinking alcohol daily (strong cider 8.4%). He drank alcohol on wakening otherwise he was tremulous and unable to get up. He had been drinking at this level for five years. He said he had been assaulted two months previously and this had resulted in a skull fracture requiring an operation at the local hospital. He confirmed that he had a problem with his memory since the assault.

The detainee was aware of the reason for his arrest but couldn't remember whether he had ever been arrested before. He was calm, cooperative, alert and orientated in time, place and person, and the mental state examination was entirely *normal. He was tremulous, sweating with a blood pressure of 145/95 and pulse 98 beats per minute. The HCP concluded that there was evidence of alcohol withdrawal and provided treatment (a long acting benzodiazepine diazepam 10 mg). The HCP advised the police that in view of the history of an acquired brain injury and severe alcohol dependence the detainee would require the presence of an appropriate adult.*

Substance Misuse and Fitness for Interview

A substance misuser may be rendered unfit for interview by virtue of either intoxication or withdrawal. Generally speaking, intoxication is easy to recognize, and the police will usually wait until the intoxication has cleared before starting their questioning. However, problems may be encountered with hallucinogenic substances. For example, the mental state may fluctuate in the recovery stages of an LSD experience and some of the novel psychoactive substances with hallucinogenic properties e.g. tryptamines and phenethylamines, which may not be immediately obvious to the interviewer [75].

Withdrawal states can pose a bigger problem for the doctor assessing fitness for interview. Although most confessions made in these circumstances are reliable [76], it should be recognized that the person suffering from drug withdrawal may be particularly vulnerable to providing a false confession. Such persons may believe that compliance will result in early release and that the risks entailed in providing a false confession may seem worthwhile in the presence of an overwhelming desire to reestablish access to their supply of drugs [32].

Although symptoms of mild withdrawal from opiates, for example, is considered unlikely to be a barrier to interview [46, 75], the physical and mental distress occasioned by established withdrawal may seriously impair a suspect's fitness to undergo the somewhat threatening and difficult experience of police interrogation.

When faced with a suspect suffering from severe withdrawal, the HCP should consider advising that the interview be deferred until such time as the withdrawal has subsided or been adequately treated. If the HCP decides to treat the withdrawal state, consideration should be given to the risk that the therapeutic intervention may in itself have a bearing on fitness to interview. Arranging for therapy that the suspect has been receiving in the community to be continued in police custody is unlikely to influence fitness for interview [75, 77, 78]. However, when substitution therapy is initiated in custody, or when symptomatic treatment alone is provided, the HCP may well need to assess the impact of the treatment before an interview takes place.

The Court of Appeal (Criminal Division) in *R v Crampton* (1991) 92 Cr App R 369 [79], has ruled that the mere fact that an addict is withdrawing and might have a motive for confession does not necessarily make the confession unreliable. Whether an addict is fit to be interviewed in the sense that his or her answers can be relied on as being true is a matter for those present at the time. It is therefore essential that the HCP performs a comprehensive assessment as the evidence he/she provides could be pivotal in the case.

The Impact of Psychiatric Illnesses and Personality Disorders

There has been a considerable amount of research into the manner in which certain functional psychiatric illnesses can affect the reliability of testimony [80, 81]. Thus anxiety has been shown to increase a suspect's suggestibility [82] and depression can lead to feelings of guilt and poor self-esteem that render a suspect vulnerable to providing a false confession [83]. It has been accepted that personality disorder might render a confession unreliable in *R v O'Brien* [84] and evidence of possible inaccurate elaboration on events without understanding the implications of doing so was the basis of a successful appeal against conviction for robbery in the case of a prostitute with a severe personality disorder *R v Walker* [85]. Psychiatric illness may also render a person unfit for interview by virtue of its effect on cognitive processes or because of associated thought disorder [66, 86]. However, careful questioning that avoids the use of leading questions and coercive pressures can often elicit reliable testimony. The fact that a suspect suffers from an illness such as schizophrenia does not necessarily mean that he or she is unfit for interview [87]; such an opinion would depend on the likely demand characteristics of the interview and the functional assessment by the doctor. This is reflected in Annex G of Code C of PACE and the PACE(NI)O:

> '*It is essential healthcare professionals who are consulted consider the functional ability of the detainee rather than simply relying on a medical diagnosis, e.g. it is possible for a person with severe mental illness to be fit for interview.*'

Intellectual Disabilities

Gudjonsson [88] has observed that a common theme across real-life studies is that many of the exonerated people who falsely confessed had intellectual disabilities. The police and HCPs rarely have difficulty recognizing moderate or severe learning difficulties, but borderline or low-normal intelligence may not be obvious even to trained observers [89–91]. The identification of those with ID on arrest is important to ensure that they receive the support they need and access to the appropriate services to help them understand what is happening as they go through the CJS [92]. The FFLM recommends use of a short questionnaire to ascertain the presence of an ID [93]. Detainees with ID will be particularly vulnerable and are likely to believe that they do not need legal advice, will be allowed home after confessing and will be believed if they retract a false confession [94]. Such individuals may have difficulties in understanding the caution, understanding and exercising their legal rights, making informed decisions and in communicating with police officers. They are also more likely to be suggestible and acquiescent [95].

A recent case of *Miller v DPP* [96] has confirmed how important the role of the AA is in supporting an individual throughout the custodial process. In this case the detainee had been arrested for failing to provide a specimen of blood in breach of s 7 of the Road Traffic Act 1988. The detainee was known to suffer from autism and intellectual disability and on appeal the court stated that there was a very real possibility that the presence of an appropriate adult would have calmed the detainee and led him to behave differently and make different choices from those he in fact made. An AA must be present so that the suspect can understand the gravity of his decision not to provide a specimen.

Neurodevelopmental Disorders

Gudjonsson [97], summarizing the results of four studies, has suggested that persons who are symptomatic for attention deficit hyperactivity disorder (ADHD) are two to three times more likely than their 'peers' to make false confessions during police questioning.

Detainees with autistic spectrum disorders (ASD) are also at risk. In *L & R v R* [2011] EWCA Crim 649 [98] the Court of Appeal ruled that an interview with L, conducted in the absence of an appropriate adult and a solicitor, should be excluded as there was evidence that L, who showed signs of ASD, was '*suggestible particularly when under pressure and when required to respond to complex statements or questions'* and was at risk of giving erroneous answers in response to a confrontational style of questioning.

The Effect of Physical Illnesses on Fitness for Interview

The presence of any physical illness renders an individual more vulnerable when faced with a stressful situation such as a custodial interrogation. Features such as anxiety or depression will affect a person's ability to function during the police interview, and physical illness, especially if severe, is as likely to cause anxiety and depression as any other form of stress [99]. The severity of the emotional response will depend on the nature of the illness itself, the personality of the individual and social circumstances. Suspects who are already coping with physical illness are more likely to focus on the short-term consequences of their behavior than the long-term ones, thus increasing the risk that they might provide a false confession.

As the impact of physical illness on a person's coping strategy is not disease specific, depending more on the actual or perceived severity of the illness rather than the nature of the illness itself, the actual diagnosis is unimportant. By contrast, there are many physical illnesses in which characteristic disturbances in cognitive functioning have been recognized [100]. With these illnesses, the nature and degree of the mental disturbance produced depends entirely on the diagnosis of the underlying condition. The more common of the conditions encountered in custody are discussed below.

Epilepsy

It is now clear, after long historical dispute, that a predisposition to epileptic fits does not mean per se that there will be associated intellectual impairment, personality disorder, or mental illness. Most epileptic patients remain mentally normal, although this does depend on the presence, site, and extent of any brain damage underlying the epilepsy [101].

However, people with epilepsy without significant brain damage do, nonetheless, remain prone to cognitive impairment, particularly memory impairment, as a result of their epilepsy and its treatment. The potential impact of this cognitive impairment has to be considered when assessing fitness for interview in a suspect with epilepsy.

For example, problems with concentration, memory, and intellectual functioning can be seen when anticonvulsant drugs are administered in toxic doses or unsuitable combinations [102]. Suspicion should be raised when a suspect complains of mental lethargy or appears to be performing below expected levels, symptoms particularly associated with toxicity.

Further problems with the reliability of testimony from suspects with epilepsy may be related to their personality. Patients with epilepsy are often overprotected in childhood by concerned parents and, later in life, can be exposed to profound social and occupational discrimination [103]. All these factors can lead to personality problems, which include feelings of insecurity, low self-esteem, and dependency. Individuals with these personality traits are likely to be highly suggestible and may strive to please interviewing officers by giving answers that seem plausible and consistent with the external cues provided, even though the responses are known to be untrue.

The neurophysiologic consequences of an epileptic fit can in themselves seriously distort an individual's perception of events occurring around the time of the fit, thus rendering any subsequent account of that event potentially unreliable. Complex disturbances of thinking, memory, or awareness may feature as part of an aura preceding the actual seizure. These may include distortion of time sense, mental confusion, or feelings of depersonalization or déjà vu. The fit may also be ushered in by distorted perceptions or actual hallucinations of sight, hearing, taste, or smell. When the ensuing fit is mild or abortive, the connection between these reported experiences and their epileptic causation may be missed [103].

In March 2017 the classification system for seizures was revised [104] with a new nomenclature based on where seizures begin in the brain; the level of awareness during the seizure; and other features of seizure.

Cognitive disturbances can follow in the wake of seizures, with clouding of consciousness and disorientation lasting for a few minutes or up to an hour or more, so that recollection for events occurring during the postictal period may also be unreliable [101].

Head Injury

Head injuries may occur in a number of circumstances involving possible criminal offenses such as road traffic collisions and assaults; therefore, it is not uncommon to encounter head-injured detainees in police custody. The potential for the head injury to affect the person's ability to recall the details of the accident or assault can assume considerable importance.

Memory loss for events occurring around the time of the injury is likely to occur whenever there has been diffuse brain damage of a degree sufficient to cause concussion. In most cases loss of consciousness will accompany the head injury, but this is not invariable, and it is possible for patients to display both retrograde and post-traumatic amnesia without losing consciousness [100].

Retrograde amnesia refers to the loss of memory for events that immediately precede the head injury. Individuals can often indicate with fair precision the last event that they can clearly recollect. In road traffic collisions the journey may be recalled up to a specific point, which allows an estimate of the extent of the pre-traumatic gap to be made. Such amnesia is usually short in duration and can usually be counted in minutes or hours rather than days or weeks. Indeed, when the retrograde amnesia lasts for a long time the explanation is often due to hysteria.

Retrograde amnesia may render a suspect unfit for interview immediately after the head injury, but the HCP should be aware that the extent of the amnesia can change with time. At first it may be very long, but it can then shrink over the next days and weeks, eventually ending up as a matter of minutes only. Recovery from retrograde amnesia tends to occur in chronological order, with items in the distant past recovering first.

By contrast, post-traumatic amnesia refers to the period from the moment of the injury until normal continuous memory returns, the length of the amnesia providing a good index, albeit in retrospect, of the severity of the brain damage [105]. It should be emphasized that the amnesia only ends when the person becomes able to give a clear and consecutive account of what is happening around him or her. Sometimes "islands of memory" will be exhibited, but these should not be taken as indicating the end of the amnesia. There is a similar danger in underestimating the duration of post-traumatic amnesia in those suspects who, although aware of things going on around them, are unable to recall these events at a later date [100].

A variety of behaviors may be exhibited during the period of post-traumatic amnesia, ranging from apparent normality to obvious confusion. In general, however, behavior is unremarkable, and the HCP may be easily misled into believing that there is nothing amiss. The individuals themselves are usually unaware of the abnormal memory at the time and can give superficial or made-up explanations for any defects that are discovered. Occasionally these false memories can appear most convincing [106].

Migraine

Migraine is a common and sometimes incapacitating disorder, affecting approximately 20% of women and 15% of men at some time in their lives [107]. Some degree of mental change is almost universal during attacks. Anxiety and irritability are common early in the attack and are often followed by drowsiness and lethargy. Cognitive impairment may occur. Cerebration is often slowed with poor concentration, and there may be marked impairment of memory [100].

Detainees who claim that they suffered an attack of migraine at or around the time of the alleged offense should be questioned closely about any cognitive impairment during previous attacks. However, it should be recognized that the pattern of any such impairment can change from attack to attack in the same person.

Hypothyroidism

A detainee who is being adequately treated for hypothyroidism poses no particular problem for the HCP assessing fitness for interview. However, an individual with undiagnosed or undertreated hypothyroidism may exhibit mental manifestations that are as important as the physical. The typical picture is of mental lethargy, general dulling of the personality, and slowing of all cognitive functions. In particular, the hypothyroid patient shows deficits in memory, abstraction, conceptual organization, and mathematical ability [108].

Diabetes Mellitus

Although confusion is a prominent feature in patients who are slipping into hyperglycemic coma, this condition is rarely seen in police custody. Questions relating to fitness for interview and the potential reliability of a detainee's confession are more likely to involve those with hypoglycemia.

Episodes of hypoglycemia are associated with irritability, anxiety, and panic in the early stages. As the episode develops, the individual becomes disinhibited and may exhibit childish or aggressive behavior that often mimics drunkenness. Disorientation and mental confusion are common and, in severe cases, the person may pass into a coma. Anybody suffering from hypoglycemia will prove to be a poor witness to events that occur during the episode. Most will have complete amnesia for the content of the attack and occasionally for an additional period before the attack occurred when their behavior will have appeared to be normal [109]. The HCP should take a clear history of any hypoglycemic episodes that may have occurred prior to arrest and should consider checking the blood glucose of any diabetic about to be interviewed by the police. The manifestations of hypoglycemia with subsequent impaired intellectual function are extremely variable, and it has been recommended that the blood sugar should be kept at 6 mmol/L or more if a diabetic person is to give a statement or be interviewed [63].

Dementia

It is estimated that there are 850,000 people in the UK with dementia with the main sub-types Alzheimer's disease, vascular dementia, mixtures of these two pathologies ('mixed dementia') and rarer types such as Lewy body dementia, dementia in Parkinson's disease and fronto-temporal dementia [110].

However, in many of these patients the dementia is not recognized until there is some form of crisis in their lives. Such a crisis may be precipitated by sudden illness, bereavement, or police arrest. Individuals seem able to develop strategies to cope with their daily tasks and thus appear to function normally until the crisis disrupts the status quo and exposes the degree of their dementia [111].

Although there are many different causes of dementia, the clinical picture remains broadly similar, with any variation depending mainly on the age of onset of the illness, premorbid personality, and intelligence. In the custodial situation the doctor is likely to encounter only those at an early stage of the disease. This is characterized by impaired memory, loss of the sense of time, and spatial disorientation, all of which can distort a suspect's recollection of events. This distortion may be compounded by the lack of judgment that is frequently displayed by those with dementia and that can cause the suspect to misjudge the importance of providing reliable testimony [100].

Therefore it is important that the HCP be aware of the possibility that an elderly suspect may be suffering from dementia, even when there are reports of apparently normal social functioning prior to arrest. In such circumstances recognition of the dementia can be facilitated by using a standard test of cognitive function, such as the Abbreviated Mental Test Score (AMTS) [112], the Six-Item Cognitive Impairment Test [113] (6CIT http://6cit.co.uk/test/) or the Mini-Mental State Examination Score [114].

Illustrative Case *An 80 year old man was arrested for shoplifting. The police performed a routine risk assessment on his arrival at the police station and found that he appeared to be 'confused'. The HCP was called to assess the detainee for fitness to be detained and fitness to be interviewed. The HCP concluded, after performing a comprehensive assessment, including a Mini-Mental State Examination, that the detainee had dementia. The HCP advised the police that the detainee was not fit to be interviewed, and was unlikely to be fit for interview at any stage due to the diagnosis of dementia. There was a definite risk that anything the detainee said in the interview might be considered unreliable in subsequent court proceedings. Furthermore the detainee's condition was unlikely to improve. Referral to the adult safeguarding team was recommended having regard to the detainee's vulnerability. The police were advised to inform the CPS that prosecution in this case would probably not be in the public interest.*

Fitness to Be Charged

A person will be fit to be charged if he/she is capable of:

- understanding the meaning of the written notice detailing the particulars of the offence (which should be stated in simple terms as well as following the precise wording of the offence in law); and
- understanding the meaning of the statutory warning that precedes the details of the charge.

Fitness to be charged is not the same as fitness to be interviewed, as those vulnerabilities that render an individual more likely to give a false confession to the police are not relevant when considering fitness for charge. If a suspect is fit to be interviewed then he/she will also be fit to be charged unless there is any material change in their condition. Children and the mentally vulnerable should have the appropriate adult present when they are charged.

Conclusions

The Innocence Project [115] found that in about 25% of DNA exoneration cases innocent defendants made a false confession or incriminating statement. The importance of the electronic recording of all interviews has been highlighted. Currently in the US nearly half the states have a requirement for audio recording of all interviews. This occurs routinely in England and Wales. In New South Wales interviews are video and audio recorded. Whilst this makes it easier to assess the interview process, video and audio recording interviews does not necessarily ensure that false confessions do not occur.

It is essential that HCPs working in the field of general forensic medicine have the necessary competencies to be able to adequately assess a suspect with regard to fitness to be interviewed. Forensic physicians with sufficient experience of, and relevant qualifications in general forensic medicine, as well as forensic psychiatrists, may also assist in potential appeals where it is suspected that a conviction has resulted from a false or unreliable confession which should have been ruled inadmissible at trial [116].

Key Points

- A comprehensive assessment by the HCP who has the appropriate competencies (knowledge, skills, and experience) is required to assess a suspect with regard to fitness to be interviewed by the police.
- The HCP's primary concern is to recognize any characteristics that might render the individual vulnerable to providing a false or otherwise unreliable confession so that adequate safeguards can be put in place.

Self-Assessment Exercises

1. Describe the five types of false confessions.
2. What is the role of an appropriate adult?
3 Outline a scheme to recognize vulnerabilities in the assessment of fitness to be interviewed?

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12 Substance Misuse

Margaret M. Stark

Learning Objectives
To demonstrate the ability to take a detailed substance use history.
To identify the symptoms and signs of alcohol withdrawal.
To describe the clinical effects of commonly used illicit drugs.
To manage the treatment of a detainee dependent on opiates.

Introduction

There are a significant number of individuals passing through the criminal justice system with substance misuse problems and it is essential that healthcare professionals (HCPs) working in the field of clinical forensic medicine are aware of the current drug trends in their area and have been trained to a standard to practice competently in this field [1]. In England for example, The National Drug Treatment Monitoring System (NDTMS) [2] consistently reports that approximately a quarter of all referrals into treatment are generated via criminal justice sources.

Statistics

Different jurisdictions collect information from different sources in an attempt to establish patterns of drug use, and the harm that results. The statistics quoted below are not directly comparable, but give an indication of drug use within a particular country.

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Statistics from the Crime Survey England and Wales 2017/2018 [3] reveal that around 1 in 11 (9.0%) adults, aged 16–59, had taken a drug in the last year; with 1 in 29 (3.5%) this was a Class A drug (in the last year). This has increased over the past decade. Furthermore class A drug use among 16–24 year olds has been increasing since 2011/2012 mainly driven by an increase in powder cocaine and ecstasy use. Figures from the National Survey on Drug Use and Health (NSDUH) in the US show that in 2016, 28.6 million people aged 12 or older used an illicit drug in the past 30 days, which corresponds to about 1 in 10 Americans overall (10.6%), but ranges as high as 1 in 4 for young adults aged 18–25 [4]. The commonest illicit drug used was cannabis, followed by prescription opioids. The NSDUH statistics also indicate that in 2016, over the past year new cocaine users rose 13.6%, from 968,000 in 2015 to 1.1 million in 2016; and in relation to heroin there was 14.5% increase in new users from 828,000 in 2015 to 948,000 in 2016.

The National Drug and Alcohol Research Centre based in Sydney, Australia, runs the Drug Trends Program which identifies emerging problems in substance use in Australia triangulating data from various sources (https://ndarc.med.unsw.edu.au/program/drug-trends). Reviewing the most recent figures (2018) from the Illicit Drug Reporting System (IDRS) [5] two in five participants (41%) reported that their drug of choice was heroin, although methamphetamine remained the drug injected most often in the past month (44%). Weekly or more frequent use of crystal methamphetamine increased in 2018 (47%), continuing an upward trend that has been observed from 2010 onwards. Cannabis use remains stable, with nearly half of consumers (45%) reported using cannabis daily, and recent use of cocaine, and frequency of use, generally decreasing amongst the national sample since the beginning of monitoring (14% in 2018).

Local knowledge is key. Tramadol is a widely prescribed analgesic of the 'synthetic opiate' class. It has become a highly abused drug, causing more deaths in Northern Ireland in 2015 than any other drug [6].

Purity of illicit substances will vary between countries and from year to year; this may be reflected in the drug history obtained, with increasing amounts ingested as drug purity diminishes, or potential complications from overdose as the purity has increased beyond an individual's tolerance level. For example a spate of deaths occurred in England in 2017 related to the presence of carfentanyl in heroin [7].

In England and Wales the average purity of powder cocaine at user-level has increased over the last 3 years, from 36% in 2014 to a record high of 54% in 2016; purity of crack cocaine has also risen from a record low of 26% in 2011 to a record high of 71% in 2016; and heroin purity reducing from 35% in 2010 to a low of 18% in 2011 (secondary to reduced supply following on the heroin drought) to 43% 2016 [7]. In the US the Drug Enforcement Administration (DEA) collates information from a variety of sources on drug purchases submitted as evidence to DEA laboratories for analysis [8]. During the period 2012–2016 cocaine purity increased from 49.1% to 62%; heroin from 29.8% to 32.3%; and methamphetamine purity from 87.9% to 94%.

Similar statistics regarding purity are collated in Australia with the annual median purity varying between states and territories:

- amphetamine ranged from 1.5% in Queensland to 6.2% in New South Wales
- methylamphetamine ranged from 73.3% in Queensland to 82.0% in Victoria
- phenethylamines ranged from 1.8% in South Australia to 52.5% in New South Wales
- heroin ranged from 17.0% in Victoria to 71.0% in Western Australia
- cocaine ranged from 33.2% in Queensland to 60.5% in Western Australia [9].

There are now well established global surveys to determine trends in drug use. The World Drug Report [10] in 2019 reporting that the severity and complexity of drug use is increasing with 35 million people worldwide suffering from drug use disorders while only 1 in 7 people receive treatment. The Global Drug Survey (https://www.globaldrugsurvey.com/) is typically completed by young, mainly recreational drug users, revealing that the most popular drug used in this selected survey group is cannabis, followed by ecstasy. Data on the drug situation in Europe is collected annually from member States and includes the prevalence of drug use with information on seizures, price, potency and purity of individual drugs [11].

Wastewater analysis is a relatively new scientific method to estimate the quantity of drugs consumed by a community by measuring the level of illicit drugs and their metabolites excreted in urine [12]. There is a Europe-wide network (Sewage analysis CORe group (SCORE)) that coordinates research. A distinct geographical and temporal pattern of drug use across European cities has been found [13]. Benzoylecgonine (BE) has been found in wastewater at higher levels in western and southern European cities, especially Belgium, Netherlands, and UK compared to eastern European cities; amphetamine levels were at the highest in northern and east European cities. Interestingly and perhaps not surprisingly, high levels of amphetamine, BE and MDMA have been found in wastewater during the weekend than during weekdays. Drug testing at festivals has been carried out in an attempt to reduce drug-related harm [14].

Drug related deaths are increasing in the UK with the largest number of deaths associated with heroin, and the proportion of deaths involving cocaine also continuing to rise [7]. Deaths involving Novel Psychoactive Substances (NPS) have increased since 2010 in England, Wales and Scotland. The nature of the NPS involved in deaths differs between the two countries with cathinones (mainly mephedrone) responsible for the largest proportion of NPS deaths in England and Wales since they were first recorded in 2010, whereas benzodiazepine-type substances (in particular etizolam) were implicated in 98% of deaths involving NPS in Scotland in 2016 [7]. Hospital admissions related to drugs also provide evidence. Over the past 20 years, there was a fourfold increase in the rate of drug-related general acute hospital stays in Scotland (from 51 to 199 stays per 100,000 population), with a sharper increase observed in recent years [15]. There is significant global burden of disease from both alcohol and drug use [16]. In the forensic environment deaths in custody often involve drugs and alcohol (see Chap. 13).

Drug Facilitated Crime (DFC) and Drug Facilitated Sexual Assault (DFSA)

The UK Government published a Serious Violence Strategy in 2018 stating that drugs have been an important driver of the increase in serious violence in England and Wales since 2014 [17]. The report linked drugs to violence directly via their psychoactive effects, and indirectly by fueling crime, such as robberies to service drug dependence, or through violent competition between drug dealers. It further concluded that crack cocaine markets are linked to serious violence and there has been a rise in use in England. The increase has been explained by a number of factors: aggressive marketing by the drug dealers, easy accessibility to the drug, affordability, an increase in county lines drug dealing activity, a reduction of police focus on drugs and less stigma with crack cocaine use [18]. There has also been a global increase in the production of cocaine [19].

For a HCP working in general forensic medicine or in sexual offence medicine consideration should always be given to whether drugs have been used, not only to assess the condition of the complainant or suspect at the time of the examination, but also whether there is any indication that drugs have been administered and effected the situation.

Drug facilitated crime (DFC) is any crime in the course of which the victim is administered a drug, or other incapacitating substance, in order to affect control over their actions, decision making, or mental or physical capabilities [20]. This may occur in a variety of circumstances, including cases of drug facilitated assault (DFSA).

Two forms of DFSA have been recognized [21]. Proactive DFSA involves the covert or forcible administration of an incapacitating or disinhibiting substance, by an assailant, for the purpose of sexual assault. Opportunistic DFSA involves sexual activity, by an assailant, with a victim who is profoundly intoxicated by his or her own actions to the point of near or actual unconsciousness, and thus lacks the capacity to consent.

Where DFC/DFSA is suspected samples of urine and blood need to be taken as soon as possible (see Chap. 3). Many jurisdictions use an Early Evidence Kit (EEK) that includes the taking of a urine sample. This can be facilitated by law enforcement/emergency department personnel/other first responders before the forensic HCP arrives to undertake a full forensic assessment. EEKs should be widely available as delay in obtaining samples will result in the metabolism of shorter acting drugs so that they are no longer reliably detected in blood and urine [22].

Timescales for the collection of forensic samples should be based on evidence including statistical feedback from the local laboratory. Currently blood samples are recommended within 24–72 h and urine up to 5 days [23–25]. In cases of DFC/DFSA there is often a delay so hair samples may provide evidence of drug use some time after an incident [23], including single dose exposure [26]. However it should be remembered that drugs and their metabolites found in hair may arise not only from deliberate drug administration and other factors may affect the interpretation of results [27].

Alcohol is by far the commonest drug to be implicated in DFSA but polydrug use is common and this maybe because of voluntary ingestion or be covertly administered [28, 29]. Cannabinoids and ethanol, and benzodiazepine and alcohol, appear to be common combinations [20, 30]. Interpretation of drug and/or alcohol levels will be depend on may factors but the HCP should ensure that they take a detailed history of any substances misused, as outlined in this chapter below. Back calculations for alcohol from the complainant's blood alcohol concentration (BAC) from the time of sampling to the time of the alleged offence can be made. This is not recommended on urine [31]. The urine alcohol concentration (UAC)/BAC ratio is highly variable depending on many factors including time of the last bladder emptying before providing the urine sample for toxicological analysis [32].

General Principles [33]

History and Examination

A detailed history of recent drug use, including alcohol, needs to be obtained to establish whether the individual is a currently dependent or a recreational user (Table 12.1). Street names of substances will vary from country to country, within regions in the same country, with the cultural background of the user, and over time. The examination should look for signs of intoxication, withdrawal, or previous drug use (Table 12.2). Baseline parameters are useful for re-examination if the detainee is kept in custody. The method of administration of a drug may include enteral, parenteral, topical, and by inhalation and the speed at which the peak plasma levels of a drug are reached depends on the route of administration [34]. Those that are rapidly released have a greater abuse potential.

In recent years more research has been undertaken into the health needs of those detained by the police and this shows that in this population [35–37] mental health problems, including substance use disorders, and physical ailments, are highly prevalent, often requiring emergency referral (see Chap. 9). Many detainees are homeless and this is associated with multiple complex needs [38]. As well as taking a comprehensive substance use history it is essential that the HCP take a full medical history including [39]:

Table 12.1 Substance misuse history

Type of substance used
Period of substance use
Quantity taken per day, on an average/typical day
Amount spent on substances per day
Frequency of use
Routes of administration (noting any sites of injection)
Amount used in the past 24–48 h
The time of the last dose(s)
Currently prescribed drugs
Experience of withdrawal

Table 12.2 Substance misuse examination

Level of consciousness—AVPU/GCS
Blood pressure
Pulse rate
Temperature
Pupil size
Orientation in time, place, person
Agitation, restlessness
Delirium/psychosis/disordered perceptions
Speech—content and articulation
Flushed
Pallor
Tremor
Yawning
Lachrymation
Rhinorrhoea
Gooseflesh
Sweating
Examination of the cardiovascular system—check heart sounds
Examination of the respiratory system—auscultation of chest
Bowel sounds
Presence of needle tracks
Coordination
Gait
Romberg's
Mental state examination (MSE)
Use of withdrawal sales CIWA-Ar & COWS

- presenting symptoms of a physical or mental health problem
- complaint of recent injuries, including use of force during arrest
- past medical history including operations, injuries, (especially significant head injuries) and periods in hospital
- past psychiatric history including periods in hospital, contact with mental health team
- for women, relevant contraception history, cervical screening, menstrual and pregnancy history
- consideration of sexual health and history of sexually transmitted infections (including any partners with HIV or hepatitis B, C)
- oral health problems
- current prescribed medication

The use of an onsite drug testing kit in police stations may be of assistance [33]; however, these tests are qualitative rather than quantitative indicating that a substance has been used rather than how much has been taken, or whether the detainee is dependent, so care is needed in the overall interpretation. Urine tests have been used as part of the clinical management in police custody settings [40] and the results of oral fluid sampling undertaken by police may be available.

Pregnant detainees need very careful assessment and management as sudden cessation of opioid use in a pregnant woman with dependence may be life-threatening for the fetus. Special care should be taken to ensure that a pregnant, opiate-dependent woman's medication is continued while she is in custody. There should be a low threshold for referral for hospital assessment, especially in the third trimester. It is important to consider whether or not a female detainee is pregnant before initiating treatment. Detailed guidance has been issued for the management of pregnant detainees in police custody [33].

Medical Complications of Substance Misuse

Medical complications of substance misuse may give an indication of a problem in the absence of acute symptoms or signs of intoxication or withdrawal [41]. Intravenous injection may result in superficial thrombophlebitis, deep vein thrombosis and pulmonary embolus, and chronic complications of limb swelling and venous ulcers. If injection occurs accidentally into an artery vascular spasm may result in ischemia which, if prolonged, can lead to gangrene and amputation.

Cellulitis and abscesses may be seen around injection sites, and deep abscesses may extend into joints, producing septic arthritis. Self-neglect, malnutrition, and dental decay may occur, as may infectious diseases such as hepatitis B, C, HIV, and the acquired immunodeficiency syndrome (AIDS). An outbreak of anthrax among injecting heroin users in 2009–2010 from contaminated heroin, occurred due a single novel strain of anthrax not previously seen in the UK, but found to related to anthrax strains previously identified in goats in Turkey [42].

Skin manifestations of drug use [43] may be seen more commonly in opiate rather than stimulant users, even though stimulant users inject more frequently. This is partly because stimulants do not cause histamine release and are therefore seldom associated with pruritus and excoriations and also because cutaneous complications are frequently caused by the adulterants injected along with the opiates, rather than the drugs themselves. Fresh puncture sites, tattoos used to cover needle tracks, keloid formation, track marks from chronic inflammation, burns, ulcerated areas and skin popping resulting in atrophic scars, necrotizing fasciitis, acute generalized exanthematous pustulosis, fungal infections, hyperpigmentation at sites of healed abscess, puffy hands (lymphoedema with obliteration of anatomic landmarks and pitting edema absent), and histamine-related urticaria (opiates act on mast cells resulting in histamine release) may be seen.

Reducing Health Risks

Information and advice should be given to the detainee by the HCP on reducing the harm from continued drug misuse. Advice can be provided on a range of issues [33]:

- encouraging the detainee to see their general practitioner and/or attend hospital clinics to receive the appropriate care for long-term conditions.
- referral to an on-site arrest referral/drug worker (if available see below)
- information being provided about local agencies involved in counselling and treatment of substance-related problems, such as community drug and alcohol teams, treatment centres and needle exchange schemes
- advice regarding testing for blood-borne virus infections, hepatitis C and HIV, with referral for treatment if required
- information and advice about, and immunisation against, hepatitis B (and possibly hepatitis A) (see Chap. 10)
- tetanus immunisation status should be checked in people who inject drugs
- education on the hazards of injecting drugs, particularly with regard to shared injecting equipment
- education on the risks of overdose, of multiple use of substances, including alcohol, and of the variable purity of illicit drugs
- advice regarding the loss of tolerance and risk of fatality following reduction in regular use or a period of abstinence such as may occur following time in prison or residential rehabilitation
- contraception advice, reminders regarding cervical cancer screening, and safer sex advice and, where required, referral to sexual health service
- referral to dentists with oral health problems—dental caries, tooth erosion, periodontal disease.

Substance misusers who inject may have experienced a broken needle at some time in their injecting career [44]. Central embolization may occur within a few hours up to several days and this can lead to potentially fatal consequences including pericarditis, endocarditis, and pulmonary abscesses. Needle fragments need to be removed as soon as possible to avoid future complications. This may be done by the users themselves or necessitate attendance at the emergency department.

Brief interventions, whereby it is possible to provide advice about the risks inherent in a range of patterns of substance use and to advise reducing or stopping use as part of screening and assessment [45], should be used opportunistically in the criminal justice system. A person's motivation to change is important in determining the likelihood of success of any intervention [46], and such motivation may alter depending on a variety of factors. For example, negative life events such as being arrested for an acquisitive crime motivated by a need to finance a drug habit can introduce conflict in the detainee's mind about substance misuse and may increase the likelihood of successful intervention.

There is no longer a national Drug Intervention Programme (DIP) [47] in England and Wales which had the aim of identifying Class A drug (heroin and cocaine) users by testing them on charge, and directing them into drug treatment in an attempt to reduce offending behavior. Individual police forces have the discretion to opt in or out of legacy DIP powers including testing on arrest, required assessments, and restrictions on bail. Consequently, the implementation of these provisions varies from area to area. HCPs should be aware of whether there is access to

Criminal Justice Integrated Team (CJIT) workers (or equivalent) who are members of a multi-disciplinary team providing support, advice, brief and structured interventions to individuals, with substance use disorders within the criminal justice system.

Older People with Multiple Co-morbidity

There is an increasing older population with substance use disorders in the community [38, 48, 49]. HCPs may see older detainees on opiate substitution treatment (OST), as well as other medications, with complex and multiple health problems. There are a group of early onset substance users with a long history, usually of poly-substance use (heroin, crack/cocaine, tobacco and alcohol) persisting into later life. There are also late onset users of substances who may have begun using substances regularly later in life, often following stressful life events or lifestyle changes.

Prescribing

Although prompt treatment to limit or prevent the withdrawal syndrome is desirable, no central nervous system (CNS) depressant medication should be given if there is evidence of intoxication with other drugs, for example, alcohol, as many substances have an additive effect, or even, synergistic effect. Consideration of whether the detainee is fit for detention is the priority. Most individuals are not detained in police custody for very long, and therefore medical treatment may not be required. This is particularly so if there is any question that the detainee may have recently ingested substances the full effects of which may not as yet be obvious. Reassessment after a specific period should be recommended depending on the history given by the detainee and the objective examination findings.

Details of medication should be verified whenever possible. It is good practice for all new substitute opiate prescriptions to be taken initially under daily supervision [39]. In the custodial situation if the detainee is on a supervised program of therapy, one can be reasonably sure the detainee is dependent on that dose; the detainee may of course be using other illicit substances as well. Recent urine test results may be checked with the clinic to see whether methadone or other drugs are detected on screening.

With OST in particular, in the absence of withdrawal signs, confirmation of such treatment should be sought before authorizing continuation. The prescribed dose of OST may not necessarily indicate accurately the actual amount taken each day if not supervised, as part or all of the dose may be given to other individuals. If there is doubt about the daily dose, then the dose can be divided and given every 12 h. It should be remembered that giving even a small amount of opiates to a nondependent individual may be fatal. Cocaine abuse appears to accelerate the elimination of methadone; therefore, higher doses of methadone need to be prescribed to individuals on maintenance regimes who continue to abuse cocaine [50]. Any decision to prescribe should be made on the assessment of objective signs as opposed to subjective symptoms, and a detailed record of the history and examination should be made contemporaneously. If there is any doubt as to the interpretation of the given history, findings on physical examination, and need for prescribing then it is essential to seek advice from a senior colleague.

Good practice dictates that where treatment can be verified it should be continued as long as it is clinically safe to do so. Evidence from the National Treatment Outcome Research Study (NTORS), a prospective study of treatment outcome among substance misusers in the UK, has shown substantial reduction across a range of problem behaviors 4–5 years after patients were admitted to national treatment programs and it is important not to disrupt such programs [51]. Individuals referred from the criminal justice system have been found to have more complex offending patterns and chaotic problems, although a significant majority 73% have been in treatment before [52]. So it is important to facilitate reinitiating treatment for this "difficult group."

Specific Drugs

Pharmacodynamics refers to the effect of substances on the body, and the acute and chronic effects of substances take place at receptors (see Table 12.3). There are now seven main criteria for substance dependence (see Table 12.4). The detailed guidance on the clinical management of acute and chronic harms of the specific drugs outlined below, including the novel psychoactive substances (NPS), can be found in a variety of texts [33, 39, 53, 54]. A brief summary will be given in relation to management in police custody.

Opiate Intoxication and Withdrawal

The characteristics of the medical syndromes in opiate intoxication, overdose, and withdrawal are given in Table 12.5. Opiates such as heroin may be taken orally, more usually injected, or smoked. The start of withdrawal will vary in time with the different opioid drugs, and it should be remembered that the severity of withdrawal symptoms is influenced greatly by psychological factors [55]; the environment of a police cell is likely to exacerbate these symptoms.

Chronic administration of opiate drugs results in tolerance (Table 12.4) to effects such as euphoria mediated by the opiate receptors and to the effects on the autonomic nervous system mediated by the noradrenergic pathways. Tolerance to heroin can develop within 2 weeks of commencing daily heroin use, occurs more slowly with methadone, and may go as quickly as it develops. With abrupt withdrawal of opiates, there is a "noradrenergic storm," which is responsible for many of the opiate withdrawal symptoms (Table 12.5). Many opiate users are also dependent on benzodiazepines and concurrent benzodiazepine withdrawal may increase the severity of opiate withdrawal [57].

Table 12.3 Primary target and main effects of addictive substances in the brain

Drug	Primary target	Main effects	Other actions
Opiates	Stimulate mOR receptor	?	Stimulate delta and kappa opioid receptors
Heroin			
Morphine/ methadone			
Buprenorphine	Less stimulation of mOR		
Stimulants			
Amphetamines	Promote dopamine release	Increase dopamine	Increase norepinephrine, serotonin, and endorphins
Cocaine	Blocks DAT	Increases dopamine	Inhibits norepinephrine reuptake
Nicotine	Stimulates nicotinic receptor	Increase dopamine	
Sedatives			
Alcohol	Simulate $GABA_A$ receptor	Increases GABA	Increases dopamine
		Reduces glutamate	
Benzodiazepines	Stimulate $GABA_A$ receptor	Increases GABA	?
Gamma Hydroxybutyrate	Stimulate GAB_A and GHB receptors	Increases GABA	Increase dopamine
Cannabinoids	Stimulate CB1 receptor	Increases dopamine	Reduces GABA and norepinephrine release
Hallucinogens			
LSD	Stimulate serotonin 5-HT_2 receptor	Mimics serotonin	Increases dopamine
MDMA	Promotes serotonin release	Increases serotonin	Increase dopamine
		Increases norepinephrine and serotonin?	

mOR muopioid receptor, *DAT* dopamine transporter, *GABA* gamma aminobutyric acid
Adapted from: Nutt DJ & Nestor LJ. Chapter 6 Pharmacodynamics of addictive substances p. 38–39. Addiction. Second edition. Oxford Psychiatry Library. Oxford University Press, Oxford 2018

Treatment of Opiate Withdrawal

A careful history and thorough physical examination should be carried out to establish the nature and severity of the withdrawal syndrome prior to treatment; use of a clinical opiate withdrawal scale (COWS) may assist in the assessment [58, 59]. Symptomatic treatment of the opiate withdrawal syndrome can often be achieved using a combination of drugs such as loperamide for diarrhea; metoclopramide or buccal prochlorperazine for vomiting; mebeverine hydrochloride or hyoscine

Table 12.4 Diagnostic criteria for substance dependence

1.	Tolerance, as defined by either of the following: (a) A need for markedly increased amounts of the substance to achieve intoxication or desired effect (b) Markedly diminished effect with continued use of the same amount of the substance
2.	Withdrawal, as manifested by either of the following: (a) The characteristic withdrawal syndrome for the substance (refer to criteria A or B of the criteria sets for withdrawal from specific substances). (b) The same (or a closely related) substance is taken to relieve or avoid withdrawal symptoms.
3.	The substance is often taken in larger amounts or over a longer period than was intended.
4.	There is a persistent desire to use the substance or unsuccessful attempts to cut down or control substance.
5.	A great deal of time is spent in activities necessary to obtain the substance, use the substance, or recover from its effects.
6.	Important social, occupational, or recreational activities are given up or reduced because of substance use. (c) The substance use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance.

From: Diagnostic and Statistical Manual of Mental Disorders (DSM-5), 2013 American Psychiatric association

Table 12.5 Medical syndromes in heroin users

Syndrome (onset and duration)	Characteristics
Opiate intoxication	Conscious, sedated "nodding"; mood normal to euphoric; pin-point pupils
Acute overdose	Unconscious; pin-point pupils; slow shallow respirations
Opiate withdrawal	
Anticipatory 3–4 h after the last fix (as acute effects of heroin subside)	Fear of withdrawal, anxiety, drug-craving, drug-seeking behavior
Early 8–10 h after last fix	Anxiety, restlessness, yawning, nausea, sweating, nasal stuffiness, rhinorrhea, lacrimation, dilated pupils, stomach cramps, increased bowel sounds, drug-seeking behavior
Fully developed 1–3 days after last fix	Severe anxiety, tremor, restlessness, piloerection (cold-turkey), vomiting, diarrhea, muscle spasms (kicking the habit), muscle pain, increased blood pressure, tachycardia, fever, chills, impulse-driven drug-seeking behavior
Protracted abstinence	Hypotension, bradycardia, insomnia, loss of energy and appetite, stimulus-driven opiate cravings

From: Ling and Wesson [56]

butylbromide for abdominal cramps and paracetamol or nonsteroidal anti-inflammatories for generalized aches. However overall there is low efficacy of non-opioid drugs in treating opioid withdrawal with only benzodiazepines having a moderate positive effect [60]. Benzodiazepines are not recommended in the routine treatment of opiate withdrawal in this setting as such drugs may affect cognition and therefore fitness to be interviewed.

Substitution treatment may be required in more severe cases of opiate dependence using a choice of methadone, buprenorphine, or dihydrocodeine [61]. As street heroin varies in purity, the starting dose cannot be accurately estimated on the basis of the amount of street drug used. Therefore, substitution therapy should be titrated against the symptoms and signs of withdrawal. For example, dihydrocodeine may be commenced in a dose of 90–120 mg three times a day, with the dose being increased if the patient has demonstrable clinical signs of opiate withdrawal [62].

Methadone

Methadone is a synthetic opioid drug, used widely in the treatment of opioid dependence with a long duration of action so it can be given once a day. There are a number of formulations including liquid, tablet and injectable. Liquid methadone for the treatment of opioid dependence is available in a number of strengths: the usual form is methadone oral solution 1 mg/mL, which is typically green, although there is a color-free mixture; methadone oral concentrate, not commonly used, is available in two strengths: 10 mg/mL (blue) and 20 mg/mL (brown).

It is important to remember that the effect of a particular dose of methadone will depend on the individual's tolerance to opioids. Tolerance can develop within 2 weeks of commencing daily use but also disappears as quickly as it develops so that a previously safe dose may prove fatal. Peak concentration is achieved 4 h after consumption and the drug has a half-life of 10–25 h after a single dose and 13–55 h after repeated doses. It is highly lipid soluble and it takes several repeated doses before tissue reservoirs are full. As long as it is clinically safe to do so, prescribed methadone, from a community drug/primary care center should be continued while in custody, as long as it is clinically safe to do so.

Buprenorphine

Buprenorphine is an opioid with mixed agonist-antagonist properties, less of a risk in overdose when taken alone. It is taken sublingually, and self-administration of the drug in the custodial environment must be personally supervised by a suitably qualified HCP who should observe the patient for 5 min to ensure that the drug has fully dissolved [63]. This is essential to prevent hoarding and further misuse [64], for example, by snorting in prison. The tablets are available in a variety of strengths and also in combination with naloxone. Different formulations of buprenorphine including e.g. freeze-dried wafer formulations; and depot preparations are now available. Peak concentration is 90–150 min, with peak effects 1–4 h post dose. The duration of action is related to dose—with a low dose of 2–4 mg effects last for up to 12 h, whereas with a higher dose of 16–32 mg effects may last for up to 48–72 h. Buprenorphine is usually administered once a day because of its long duration of action. It is essential that prescribed buprenorphine from a community drug/primary care center, should be continued in custody, as long as it is clinically safe to do so. Precipitation of opioid withdrawal can occur in someone commencing buprenorphine who is dependent on large doses of opioids or other opioid analgesics if this is started when the person is not in withdrawal.

Naloxone

Naloxone is an opioid antagonist that reverses the effects of severe intoxication (Table 12.5). The use of naloxone may precipitate withdrawal in addicted patients, but in initial doses of 0.4–0.8 mg it is relatively safe, with little risk of vomiting, seizures, hypotension, hypertension, or cardiac arrest [65]. The half-life of naloxone is shorter than that of most opiates, and therefore a period of observation in the hospital is required after administration. It is recommended to give half the dose intravenously and half intramuscularly (absorption is slower and the antidotal activity prolonged); this is useful, as often individuals discharge themselves once awakened. It is recommended to give oxygen or bag-valve-mask ventilation where RR < 10/min or SpO_2 < 92% (on air) [66]. Where severe opioid intoxication is suspected, an emergency ambulance must be called immediately and naloxone given.

Intranasal naloxone has been used in the prehospital care environment and found to be a safe and effective first line prehospital intervention in reversing the effects of an opioid overdose, avoiding fatalities, and helping to reduce the risk of needle stick injury [67, 68]. Nasal naloxone is now available in the UK as Nyxoid® a single-dose nasal spray containing 1.8 mg of naloxone (as hydrochloride) in a 0.1 mL solution (two nasal sprays are included in the carton) [69]. It is indicated for emergency administration for known or suspected opioid overdose in adults and adolescents aged 14 years and over and there should be a response within 2–3 min of administration. Heroin may be taken in combination with cocaine (“snowball”), and the use of naloxone in this situation may precipitate ventricular dysrhythmias [70, 71].

Benzodiazepines

Benzodiazepines produce physical and psychological dependence and are only recommended for limited periods (4 weeks) [72]. The drugs are commonly misused either illicitly, which usually involves high doses, or by persistent therapeutic use at a lower dose. The pharmacologic properties of the benzodiazepines are hypnotic, anxiolytic, muscle relaxant, and anticonvulsant and are produced by enhancing gamma-aminobutyric acid (GABA) transmission. There are increasing reports of the use of illicitly manufactured alprazolam, etizolam and diclazepam, often used by young people with alcohol, the concentration of drug in the pills varying widely [73].

Manifestations of intoxication and withdrawal are given in Table 12.6. Tolerance usually develops after continuous use, slowly for those drugs that have a long half-life but more quickly for the short-acting drugs. Benzodiazepines are well absorbed from the gastrointestinal tract after oral administration; food can delay the rate but not the extent of absorption.

Table 12.6 Manifestations of sedative-hypnotic drug intoxication and withdrawal

Mild	Sedation, disorientation, slurred speech, ataxia, nystagmus, amnesia
Severe	Coma, hypoventilation, hypotension, hypothermia, depressed or absent corneal, gag, and deep tendon reflexes
Withdrawal	Anxiety, insomnia, irritability, agitation, anorexia, tremor, disordered perceptions, seizures

Side effects of use include drowsiness, memory impairment especially anterograde amnesia at therapeutic doses, the risk increasing at high dosages. There is controversy about whether benzodiazepine use alone can result in disinhibited or impulsive behaviour [72]. Anxiolytics lower tolerance to alcohol and in high doses produce mental confusion similar to alcohol intoxication. The interaction between alcohol and benzodiazepines results in a potentiation of the CNS effects. In general, however, they have a very high toxic-therapeutic ratio and doses 15–20 times therapeutic dose may not cause serious side effects [74].

Sudden cessation of benzodiazepines can lead to a recognized withdrawal syndrome with anxiety symptoms, disordered perceptions, and major complications such as seizures and psychosis. A long-acting benzodiazepine such as diazepam or chlordiazepoxide is preferable in treating symptoms of withdrawal and preventing the major complications.

Flumazenil is a specific benzodiazepine antagonist used for the reversal of benzodiazepine-induced sedation and coma. When overdosage is suspected, it can be used in patients who would otherwise need intubation and ventilation [75] but care should be taken when mixed overdoses are suspected [76]. Complications such as convulsions, dysrhythmias, heart block, and cardiac arrest suggest that its use in the prehospital environment should not be encouraged [77].

Z-drugs

Z-drugs (zaleplon, zolpidem and zopiclone) non-benzodiazepine hypnotic drugs have similar effects to benzodiazepines and are relatively safe unless mixed with other central nervous depressants. Physical and psychological dependence occurs and there may be impairment of memory and cognition.

Pregabalin and Gabapentin

Pregabalin and gabapentin have been increasingly misused in recent years [78]. These drugs are used in the treatment of epilepsy, generalized anxiety disorder, for the relief of neuropathic pain, postherpetic neuralgia, diabetic peripheral neuropathy, fibromyalgia, and as an adjunct therapy for partial seizures. Clinical effects include euphoria, improved sociability, and relaxation. Adverse effects include significant CNS depression resulting in drowsiness, sedation, respiratory depression, and at the extreme, death. The majority of related deaths are in those who are also taking opioids. Withdrawal effects have been described including headache, nausea, anxiety, diarrhoea, flu-like illness, convulsions, nervousness, depression, pain, hyperhidrosis and dizziness suggestive of physical dependence. Detainees receiving prescribed pregabalin or gabapentin should have their treatment continued whilst in police custody as long as it is clinically safe to do so. Detainees misusing these drugs should be treated symptomatically.

Barbiturates

Barbiturates are used in the treatment of epilepsy and for the induction of anesthesia. They became less commonly misused following the introduction of benzodiazepine drugs but may be used by polydrug users. Mild intoxication may result in slurred speech, over sedation, ataxia, and nystagmus, while severe intoxication may present with coma, absent reflexes, hypothermia, hypotension, and respiratory depression. There is a narrow margin between therapeutic dose and serious toxicity. Physical and psychological dependence occurs, and the withdrawal syndrome is similar to that of benzodiazepine withdrawal, with a greater risk of seizures. Benzodiazepines may be used to prevent the withdrawal syndrome associated with barbiturates.

Illustrative Case *An elderly male was found collapsed in the street with a suspected opiate overdose and was taken to hospital by police. He was wanted on a warrant so after assessment at the hospital he returned to custody. The HCP was called to assess whether he was fit to be detained. The male gave a history of epilepsy currently well controlled on phenobarbitone. He also said that he was dependent on heroin. On examination he was found to be drowsy with impaired co-ordination and an unsteady gait. Further discussion with the patient revealed that he had taken an overdose of his prescribed drug phenobarbitone as he had no access to heroin and was experiencing symptoms of opiate withdrawal. The HCP telephoned the local poisons centre for advice and it was recommended that he return to hospital for a further assessment/observation.*

Solvents

Volatile substance abuse (VSA) is the deliberate inhalation of fumes given off by volatile substances (solvents) to achieve intoxication and can occur at any age but is a particular problem among adolescents. Adhesives, aerosols, anesthetics, dry cleaning agents, fuel gases, nail varnish, and paint stripper are among the substances inhaled, either directly from their containers, from a plastic bag placed over the nose and mouth, from impregnated rags, or sprayed directly into the mouth.

Regular users may have nasal sores, “glue-sniffer’s rash” (perioral dermatitis), and have the odor of solvents on their breath. Acute effects begin within minutes [79] and may last 15–45 min; persistent abnormalities may occur in severe chronic abusers (Table 12.7) [80].

Table 12.7 Manifestations of solvent intoxication and abuse [206]

Mild	Euphoria
	Disinhibition
	Dizziness
	Slurred speech
	Lack of coordination
	Sneezing and coughing
Moderate	Lethargy, stupor
	Hallucinations
	Nausea, vomiting
	Diarrhea
	Nystagmus
	Ataxia
	Tremors
	Myalgias
	Paresthesia
Severe	Coma
	Seizures
Chronic	Cerebellar syndrome: ataxia, nystagmus, tremor (toluene)
	Fatigue, difficulty in concentrating
	Parkinsonism (toluene)
	Peripheral neuropathy: symmetrical, motor, mainly involving hands and feet (*n*-hexane and naphtha)

Table 12.8 Deaths from volatile substance misuse

Acute	Direct	Immediate
		Postponed
	Indirect	Trauma
		Aspiration
		Asphyxia
		Drowning
Delayed	Direct	Liver failure
		Renal failure
		Liver tumors
		Bone marrow depression
		CNS involvement

From Shepherd [78]

Most acute direct VSA-related deaths result from cardiac dysrhythmias due to “sensitization” of the myocardium to adrenaline; deaths may also occur from indirect effects or may be delayed (Table 12.8) [81]. Animal experiments confirm that myocardial sensitivity may continue for hours after the initial inhalant exposure [82]. Tolerance may develop, and psychological dependence after long-term use and a withdrawal syndrome similar to delirium tremens has been described [83].

Lysergamides, Tryptamines, and Phenethylamines

Hallucinogenic (psychedelic) drugs include lysergamides (LSD), tryptamines (mushrooms), and phenethylamines (mescaline, 2CB, 25B-NBOMe) [53].

Lysergic acid diethylamide (LSD) is usually taken orally in a dose of 75–100 μg with effects occurring within 60 min. There is a recovery period of 10–12 h where there may be periods of normal perception and cognition alternating with degrees of intoxication, which may affect fitness for interview.

Acute effects include tachycardia, hypertension, pyrexia, dilated pupils, sweating, flushing. Emotional lability, euphoria and anxiety, distortion of time, visual and auditory illusions (although true hallucinations can occur), and synesthesia, with a mixing of the sensory input—"seeing" sounds or "hearing" smells—may all occur [84].

Both enjoyable and unpleasant effects, a "bad trip," may occur in a first-time user or with repeated use. Psychiatric adverse effects have been described, which include anxiety and panic attacks, self-destructive behavior, hallucinations, acute psychosis, and major depressive reactions. Polydrug users may use benzodiazepines to alleviate anxiety and panic attacks. Hallucinogen persisting perceptual disorder (HPPD) and flashbacks may occur. Dependence does not occur and there is no recognized withdrawal syndrome. Sensitivity to the effects drug may be reduced (tachyphylaxis).

The use of hallucinogenic mushrooms, which grow wild in many areas of Europe [85] and in the United States, though more commonly are cultivated, has been increasing. Mushrooms are usually eaten or made into tea. The effects due to tryptamines, psilocybin and psilocin, are dependent on dose and the individual reaction and sensitivity to psilocybin, previous experiences and the setting. The effects [86] range from mild feelings of relaxation, giddiness, euphoria, visual enhancement (seeing colours brighter), visual disturbances (moving surfaces, waves), to delusions, altered perception of real events, images and faces, or real hallucinations. The sensory distortions may be coupled with restlessness, incoordination, feelings of anxiety, impaired judgement of time or distance, sense of unreality or even depersonalisation. These effects may be termed 'bad trips' by users and can also involve panic reactions and psychosis-like states. Physiological effects may include dizziness, nausea, weakness, muscle aching, shivering, abdominal pain, dilation of pupils (mydriasis), mild-to-moderate tachycardia, tachypnoea, hypertension, but the body temperature remains normal.

Ecstasy (MDMA) [51]

3,4-Methylenedioxymethamphetamine, or "ecstasy," is commonly taken in an oral dose of 75–120 mg as a recreational drug within the dance culture or "rave" scene for its central stimulant and psychedelic effects (Table 12.9). The effects last for 4–6 h with tolerance developing to the acute effects. Problems occur because of its use with other drugs for example alcohol, cocaine, and ketamine. There is little evidence for

Table 12.9 Effects of MDMA (ecstasy)

Psychological	Euphoria, heightened awareness, improved sense of communication
Neuropsychiatric	Anxiety, insomnia, depression, paranoia, confusion, panic attacks, psychosis
Chronic	Depression, drowsiness, anxiety, panic disorder, aggressive outbursts, psychosis, memory disturbance
Medical	Tachycardia, hypertension, dry throat, bruxism, trismus, sweating, pyrexia, nausea, vomiting, anorexia, loss of coordination with ataxia, dilated pupils, nystagmus, hot and cold flushes, hyperreflexia

Table 12.10 Summary of the severe acute harms following the use of ecstasy

Hyperthermia/hyperpyrexia
Serotonin syndrome
Dilutional hyponatremia and hyponatremic encephalopathy
Acute psychiatric presentations: anxiety, panic, psychosis
Other isolated physiological syndromes: cardiac events, liver failure, pneumomediastinum

long-term physical dependence on MDMA, because of the different pharmacological action of MDMA having more effect on brain serotonin and less on brain dopamine function, but some withdrawal effects such as low mood are frequent.

Adverse effects (Table 12.10) such as a polydipsia, hyponatremia, and catatonic stupor have been reported [87, 88]. An acute rise in antidiuretic hormone (arginine vasopressin [AVP]) accompanied by a small fall in plasma sodium has been shown following the ingestion of MDMA. Therefore, in view of the risk of hyponatremia, individuals who take such drugs should avoid drinking fluid in excess of the body's requirement. This may be difficult because MDMA reduces the perception of thirst and impairs judgment [89], and people tend to overcompensate and consciously overdrink.

Regular users may habitually use chewing gum to overcome the effects on the jaw muscles. The clenching of teeth in the acidic environment caused by carbonated (fizzy) drinks will result in an increased likelihood of tooth wear on the back teeth [90]. Other adverse effects have been described including jaundice and hepatotoxicity [91]; flashbacks and psychosis [92]; pneumomediastinum [93]; urinary retention [94]; hyperthermia; coagulopathy [95]; rhabdomyolysis; and cardiovascular complications resulting in death [96–98]. MDMA differs from other stimulants, such as cocaine and amphetamines, in that it rarely causes paranoid feelings or aggression although the development of chronic paranoid psychosis has been described after heavy misuse of the drug [99] and the serotonin syndrome [100, 101] (altered mental state, hyperthermia, and autonomic dysfunction) has also been reported following MDMA ingestion. With regard to chronic psychological effects, there may be cognitive deficits affecting memory and recall from serotonergic neurotoxicity. 3,4-Methylenedioxymethamphetamine (MDEA) is an analog of MDMA with similar effects. 3,4-Methylenedioxyamphetamine (MDA) and *para*-methoxyamphetamine (PMA) may also be used as recreational drugs.

Cocaine and Crack

Cocaine occurs naturally in the leaves of the coca plant Erythroxylum coca, which grows predominantly in South America. Cocaine hydrochloride is a white powder that is usually snorted but can be taken orally. Crack is prepared by mixing cocaine hydrochloride with sodium bicarbonate and water and heating it. The cocaine base precipitates out and forms small "rocks" as it cools. Crack may be smoked in a pipe or heated on foil with the vapor inhaled. Both crack and cocaine may be injected.

The onset of action and plasma half-life varies depending on the route of use, very rapidly if taken intravenously or smoked compared with when snorted. The duration of effects will also vary with route of administration. Ingestion of stimulant drugs such as cocaine or amphetamine results in activation of the sympathetic nervous system with resulting euphoria followed by irritability, depression, insomnia, and paranoia (Table 12.11).

Tolerance occurs to the psychological effects of cocaine. Deaths may occur, most commonly from cardiac dysrhythmias, acute coronary syndrome, excited delirium, and stroke. Cocaine is atherogenic and induces coronary artery constriction [102]. Chronic effects include perforation of the nasal septum and rhinorrhea, and long-term use may result in a range of psychiatric problems and vascular diseases.

Cocaine produces a physical and psychological dependence, the severity of which will vary depending on the method of administration, being more severe if the drug is smoked or injected than if snorted. Dependence may result in a particular strong craving for the drug, followed by a withdrawal syndrome or "crash" with irritability, insomnia, depression, and anxiety on cessation. In conditions of police custody, the depression and inability to sleep may lead to acts of self-harm and suicide, and close supervision may be required, with consideration given to prescribing hypnotics and antidepressants.

Amphetamine-Type Stimulants (ATS)

ATS such as amphetamine and methamphetamine are usually found as white powders taken nasally, orally, intravenously, or with methamphetamine smoked. Clinical effects are similar to those of cocaine (Table 12.11), although amphetamine has a longer half-life of 6–12 h, so the duration of euphoria is longer. "Ice" is a very pure form of methamphetamine hydrochloride (98–100% pure), which is usually smoked like crack cocaine.

Table 12.11 Effects of cocaine and amphetamine intoxication

Initial low dose	Euphoria, insomnia, dry mouth, hyperthermia, tachycardia, hypertension, increased respiration, sweating, dilated pupils
With increasing dose	Irritability, impulsivity, aggressiveness, agitated delirium, paranoia, delusions, seizures

Tolerance occurs with long-term use and psychological dependence with a withdrawal syndrome of depression, anxiety, and sleep disturbance. "Speed runs" describe repeated use over a period of days with several grams of amphetamine used daily. At the end of the "run," the user may sleep for several days. Alcohol, sedative-hypnotic drugs, and heroin may be used to reduce the anxiety caused by amphetamine or, alternatively, amphetamine may be used to reduce the sedative effects of such drugs.

The diversion and abuse of methylphenidate, used in the treatment of attention deficit hyperactivity disorder (ADHD), has also been reported [103].

Serotonin syndrome may occur with the use of ATS and this is a potentially life-threatening reaction. Therapeutic drugs, for example, antidepressants such as selective serotonin reuptake inhibitors (SSRIs), monoamine oxidase inhibitors (MAOIs), tricyclic antidepressants, opiate analgesics including tramadol, are associated with the serotonin syndrome.

Illustrative Case *A female who had a history of depression and drug use with previous admissions to psychiatric hospitals, was found by police in an agitated state. The police used their powers under section 136 of the Mental Health Act 1983 to remove her to a place of safety, in this case a police station. She was agitated and violent, and was put in a cell in a 'safety suit'. A doctor observed her through the wicket but did not enter the cell and said he would call the community mental health team. She was seen to be perspiring and had removed some of her clothes. An hour later she was slumped in a corner of the cell and was found to be unresponsive. Attempts at resuscitation in the police station were unsuccessful and she was pronounced dead. The cause of death was given as serotonin syndrome.*

Chemsex is a term used mostly in relation to men who have sex with men (MSM) to describe the use of drugs during sexual activity, which is increasingly associated with unsafe sexual practices, and sexually transmitted infections [104]. Three drugs are associated with this behaviour—methamphetamine, mephedrone and gamma hydroxybutyrate. These drugs cause sexual disinhibition and high-risk sexual practices.

Khat

Khat consists of the young leaves of the Catha edulis plant and is usually chewed for its stimulant effect when fresh but may be drunk as an infusion of leaves. In the UK khat is consumed almost exclusively within communities from East Africa and the southern Arabian Peninsula [105]. The main components are cathinone and cathine, with effects similar to those of amphetamine, resulting in euphoria, increased alertness, anorexia; anxiety and insomnia may occur.

The Advisory Council on the Misuse of Drugs (ACMD) noted that khat use has the potential to develop into dependency but this is much less likely than dependency on stimulants like amphetamine, and more like the type of dependency seen with caffeine [106]. Withdrawal symptoms are reported, but do not necessarily imply a withdrawal syndrome and are more comparable to a 'morning after' experience.

Marijuana

Marijuana is the most commonly used illicit drug in the UK and the United States. It is obtained from the Cannabis sativa plant, and the principal active ingredient, accounting for the majority of effects, is delta-9-tetrahydrocannabinol (THC). There are a number of forms, including hashish (a resin), herbal cannabis (a green-colored preparation made from the leaves of the plant), and "skunk" or sinsemilla a potent form of the cannabis plant with high levels of THC on average 14.2% (as opposed to 6.3% in resin) [107], which is grown indoors using hydroponic techniques, in nutrient-rich liquids rather than soil, under grow lights or greenhouse conditions. The onset of effects is reported as being more rapid, and the hallucinogenic properties are heightened. Cannabis resin usually contains cannabidiol (CBD) thought to be protective against some of the dangerous effects of THC; sinsemilla does not contain CBD.

Cannabis is usually smoked but can be ingested as, for example, "cannabis cookies." One "joint" typically contains 10–30 mg of THC and has an onset of action of 10–20 min with effects lasting 2–3 h. Acute effects include conjunctival injection; rise in blood pressure; an increase in heart rate; sedation and euphoria, occasionally panic attacks and paranoia in some users; altered perceptions of space and time; impaired learning and memory; difficulty problem solving; and loss of coordination.

Tolerance has been shown to develop to many effects of cannabis including the "high" with chronic use, and an abstinence syndrome has been described with disturbed sleep, decreased appetite, restlessness, irritability, and sweating. Withdrawal symptoms are usually mild and short-lived, although they may be more severe in heavy regular users and especially in those who are heavy users of tobacco.

Cannabis increases the risk of psychosis especially in frequent users and may be responsible for transient exacerbations in psychotic features in those with significant mental illness. Psychotic episodes may be precipitated by relatively small quantities of high potency cannabis.

Synthetic cannabinoid receptor agonists [108] may present as vape fluids, impregnated on paper, or sprayed on flammable plant material sold as herbal tea or incense. The desired effects which occur within minutes of smoking, include relaxation, euphoria, disinhibition, but these may be followed by adverse effects such as convulsions, anxiety, bizarre behavior, amnesia, confusion, panic attacks, hallucinations, paranoia delusions, and psychosis. Duration of action is variable between 1 and 8 h. There is evidence that chronic use may be associated with tolerance which develops more quickly than for other forms of cannabis. Symptoms of intoxication are usually self-limiting and resolve spontaneously. Management of toxicity is symptomatic and supportive.

Image and Performance Enhancing Drugs (IPEDs)

IPEDs are substances used with the intention of altering or improving a person's appearance or abilities [109]. There are a range of drugs that may be used:

- Anabolic steroids and gym drugs
- Nootropics—modafinil, methylphenidate, amphetamine (used to increase cognitive functioning by students)
- Botox, dermal fillers and tanning drugs (melantan)

Any of these drugs given by injection may lead to potential health risks from direct damage from injection, blood-borne viruses, and infections or inflammation at injecting sites, especially with counterfeit substances.

Anabolic (anabolic androgenic) steroids may be taken orally or intramuscularly by body builders or other individuals who want to enhance their physical appearance. Research has shown that injections of testosterone enanthate increase muscle size and strength, especially when combined with exercise [110]. To achieve the desired effect, different steroids are taken in cycles, with rest periods in between, a regime known as "stacking," or, alternatively, increasing doses of the same steroid are taken, a so-called drug pyramid [111]. Most of the steroids sold in the UK are counterfeit rather than produced by legitimate pharmaceutical companies. Consequently, they may contain a different steroid from the one indicated on the bottle, and scant reliance can be placed on the reported dose as they may have little or no steroid in them at all [112].

General effects of anabolic steroids [109, 112] include baldness, acne, raised blood pressure, fluid retention, and a reduction in high-density lipoprotein cholesterol. Long-term effects include liver and kidney damage. Gynecomastia may occur, and the prostate gland may swell, resulting in impaired micturition. Most of these effects are dose-dependent and more likely with prolonged administration.

While the drug is being taken, there is a significant reduction in testosterone production by the testes so that sperm output and quality are decreased, and a return to normal can take many months after drug use is stopped. The effect on sex drive is variable, but overall it seems that the sex drive increases at the beginning of a steroid-using cycle, and then decreases to below normal after several weeks of use. Drive may remain below normal levels even after the drug is stopped until such time as the testes start producing testosterone again. There may also be a reduction in size of the testicles [113].

In women menstrual irregularities are reported, with permanent enlargement of the clitoris. There may also be growth of facial and body hair, male pattern baldness, and decreased breast size. Abuse of sex steroids by recreational body builders may be an unrecognized cause of subfertility [114].

Liver function tests may show abnormalities that usually return to normal once the drug is stopped. Drug-induced jaundice can be caused by temporarily impaired excretory function, and peliosis hepatitis, in which the liver tissue is replaced by blood-filled cysts, may occur, as can liver tumors [115].

Initial use may result in stimulatory effects such as increased confidence, decreased fatigue, heightened motivation, agitation, irritability, and insomnia, which may progress to argumentative and aggressive behavior and major mood disturbances including depression, mania, and hypomania [116, 117]. "Roid rage," which may be associated with violent crimes [118], seems to require a high dose of steroids over several weeks, as may occur when "stacking."

Other Body Building Drugs

Polypharmacy is common among anabolic steroid users [119]. Other drugs may be used by body builders, including tamoxifen to reduce or prevent gynecomastia; diuretics to counteract the fluid retention caused by anabolic steroids; thyroxine to increase the rate of metabolism, which might theoretically increase the ability of anabolic steroids to boost physical strength [120]; and beta human chorionic gonadotropin to alleviate testicular atrophy [121]. Nalbuphine (Nubain) is an opioid agonist/antagonist analgesic used for the treatment of moderate to severe pain, and dependence has been reported associated with anabolic steroid use [122].

Furthermore, there has been a case report of a 21-year-old body builder who was admitted after taking excessive amounts of insulin intravenously; apparently insulin is advertised in body building magazines as having anabolic properties [123]. The recreational use of caffeine to toxic levels has been reported in a body builder who presented with a grand mal seizure [124]. Clenbuterol, which is a sympathomimetic agonist (used as an oral bronchodilator in some European countries but not licensed for human use in the UK or the United States), is said to have an “anabolic-like” effect but at high dose may cause cardiac dysrhythmias, tremor, and serious hypokalemia [125].

Gamma-Hydroxybutyrate and Gamma-Butyrolactone

Gamma-hydroxybutyrate (GHB) is a naturally occurring substance in the human brain structurally related to GABA [126]. Gamma-butyrolactone (GBL) is converted to GHB in vivo post ingestion. GHB has been used as an anesthetic (although it has little analgesic effect), to alleviate narcolepsy, and to treat alcohol and opiate dependence [127]. It is available as a colorless, odorless liquid, powder, or capsule taken orally, rarely injected. GHB is rapidly absorbed, with peak plasma concentrations occurring after 30–60 min following oral administration. It has a half-life of 20–30 min [128], and effects can last from 45 min to 8 h [129].

Initial effects include euphoria followed by profound sedation, confusion, agitation, and amnesia; nausea, vomiting, and diarrhea; ataxia, seizures, hypotonia, and tremor; vertigo and dizziness; bradycardia, hypotension, and hypothermia; coma; and respiratory collapse.

There is a narrow margin between intoxication and coma [130], and the clinical effects are potentiated by use of other CNS depressant drugs such as alcohol, opiates, benzodiazepines, and neuroleptics [131]. Tolerance and physical dependence after high-dose use can develop with a withdrawal syndrome, which may include insomnia, muscular cramping, tremor, and anxiety [127]. Symptoms of withdrawal from GHB are broadly similar to those for alcohol, although of a more rapid onset, and can be treated symptomatically or with benzodiazepines or baclofen [53]. A rapid deterioration into delirium may occur in more frequent high-dose dependent users. Seizures have been reported, though less commonly than with alcohol withdrawal [132]. It may be difficult to manage in custody so hospital admission should be considered.

Illustrative Case *Stephen Port was convicted in 2016 for the murder of four men after administering fatal doses of GHB* [133]. *He was aroused by the passivity of his victims (somnophilia). The bodies of three young men, in their 20s, were found in a churchyard; all had bottles of GHB in their pockets* [133]. *Somnophilia, the desire to have sex with an unconscious, sleeping or comatose person, who is unable to respond is a paraphilia, and is distinct from cases where a substance is administered to a victim in order to take advantage of them* [134].

Ketamine

Ketamine is a commercially available anesthetic for intravenous and intramuscular use. It is commonly used for recreational purposes. It is a predominately a sedative drug but has dissociative, anesthetic, psychostimulant and analgesic actions [135]. Ketamine is a member of a group of compounds known as arylcyclohexylamines, this group also includes phencyclidine and methoxetamine. These substances produce a wide range of effects but primarily they all act as non-competitive antagonists at glutamate receptors of the *N*-methyl-D-aspartate (NMDA) sub-type [135].

It is available illicitly most commonly in powder form, occasionally as a liquid, but can also be found as a tablet [53]. It usually taken intranasally ("snorted"), but also orally, smoked, and by the intravenous route. The onset of effects depends on the route of administration: intranasally within 5–30 min, intravenously within 30 s and last about 30 min. Tolerance develops after repeated use, with a decreased duration of effect [53].

Ketamine has a wide margin of safety unless taken in combination with other drugs. A dose-dependent depression of respiration may occur, and this can be a particular problem when taken with other respiratory depressant drugs such as benzodiazepines, alcohol, or opiates occasionally resulting in death [136, 137].

Physical effects may include hypertension, palpitations, nausea, and vomiting, slurred speech, nystagmus, lack of coordination, and seizures. On recovery, "emergence phenomena" may occur, with psychological dissociation or out of body (flying or floating) sensations, confusion, hallucinations, synesthesia, and depersonalization [138]. Such dissociative states may result in the individual becoming divorced from reality, and these effects, coupled with possible loss of coordination and pronounced analgesia, can result in serious accidents to users. Ketamine has been found to induce acute and severe impairment of working, episodic, and semantic memory when used frequently [139]; some of these effects have continued 3 days after drug ingestion [140]. Such cognitive impairment may impact on a detainee's fitness for interview. There is currently little evidence about physiological withdrawal but a psychological withdrawal syndrome including anxiety, drug craving, tremulousness and palpitations has been described [135].

Ketamine use is associated with damage to the urinary system—ketamine induced uropathy [141]. This may result in dysuria, painful hematuria, urge incontinence, frequency and urgent urination, nocturia, obstruction of the urinary tract.

Alkyl Nitrites

The alkyl nitrites are volatile yellowish clear liquids that have a distinctive sweet smell. All the nitrites have vasodilatory properties and are used as a euphoric relaxant within the dance culture and to relax the anal sphincter and enhance sexual performance. The effect of inhaling the vapor, usually from the bottle or poured onto a cloth, is instantaneous and very short-lived, resulting in a "rush," but adverse effects such as dizziness, flushing, tachycardia and palpitations, headache, cold sweats, and hypotension may occur [142, 143]. Swallowing of volatile nitrites as opposed to inhaling them may result in severe methemoglobinemia [144, 145].

Novel Psychoactive Substances

Novel psychoactive substances (NPS), previously known as 'legal highs' [146], are constantly being identified see Table 12.12. There have been differing legislative strategies with regard to these substances in various jurisdictions. In the UK NPS have been banned collectively under the Psychoactive Substances Act in 2016. As with all illicit substances there will be variation in the quality of content and dose received by an individual and the effects may be unpredictable depending on individual tolerance and where the drugs have been used in combination with other substances, including alcohol. HCPs should have a low threshold for early referral to an emergency department. Public Health England have a website for healthcare professionals to report cases of suspected harm with illicit substances: https://report-illicit-drug-reaction.phe.gov.uk/. Use of NPS may influence a detainee's fitness for interview and a period of rest may be required before any interview takes place.

Table 12.12 Novel Psychoactive Substances (adapted from [33])

Depressants	GHB, GBL
	Nitrous oxide
	Dissociative drugs Ketamine Methoxetamine
Stimulants	Cocaine, synthetic cocaine derivatives Piperazines Amphetamine-type substances Methamphetamine MDMA, MDA, PMA, PMMA Mephedrone Ethylphenidate Synthetic cathinones Pipradrols and derivatives
Hallucinogens	Lysergamides LSD Tryptamines Phenethylamines
Emerging drugs	New benzodiazepines
	New synthetic opioids
	Others

Alcohol

Alcohol may be involved in crime in two ways: alcohol-defined offences such as 'drunkenness' offences (drunk and disorderly/drunk and incapable), or driving with excess alcohol (Chap. 14); or offences where alcohol may have been involved, e.g. the offender was under the influence of alcohol at the time of the offence.

Crime statistics show a clear association between alcohol intake and criminal behavior, the association being most marked in relation to violent crimes. The Crime Survey England and Wales covering 2016/2017 found that in 46% of all violent incidents victims believed offenders to be under the influence of alcohol [147]. Alcohol was a particularly prevalent factor in violent incidents between strangers in figures from 2013/2014, 64% of which were perceived to be alcohol-related [148]. In Scotland the figure of alcohol-related violent crime was 42% in 2016/2017; this is almost 100,000 alcohol related violent crimes each year [149]. In Scotland in 22% of violent crime the victim had been drinking [149] and 20% of prisoners report being drunk at the time of their offence [150].

The UK Government published a Crime Prevention Strategy in 2016 recognizing that the relationship between alcohol and violence is complex and the link between alcohol and non-violent or acquisitive crime is less well developed [151].

Alcohol is important in clinical forensic medicine because of its link with criminal activity and by virtue of the significant role it plays in a large number of assessments regarding fitness for detention [35, 36, 152, 153]. In police custody in Scotland 18–34% of detainees have alcohol problems mostly at the dependency end of the spectrum [154]. Accordingly, a thorough understanding of the metabolism, effects, and problems associated with alcohol is essential for any HCP practicing in this field, not least because the detainees with alcohol problems, particularly those with gross intoxication, are an extremely vulnerable group for whom police custody may be inappropriate [155]. This is particularly important when assessing an intoxicated detainee in police custody. Indeed, the HCP's first duty in examining such individuals should be to exclude pathologic conditions that may simulate intoxication, as failure to do so may lead to deaths in police custody [156].

Alcohol use disorder (AUD) has been defined in DSM 5 (Table 12.13).

The Metabolism of Alcohol

Ethanol, hereafter referred to as alcohol, is produced by the fermentation of sugar by yeast, a process that halts at a concentration of alcohol by volume of about 15% because of the death of yeast above these levels. There is wide variation in the alcohol content of different alcoholic beverages. HCPs must bear this in mind when trying to assess intake of alcohol.

One unit in terms of an alcoholic drink in the UK is 8 g of alcohol. In the European Union there is a requirement [157] for the labelling of alcohol content of beverages of higher than 1.2% alcohol by volume (ABV). Labelling requirements are required in many jurisdictions [158].

Table 12.13 DSM 5 Alcohol Use Disorder (AUD)

1	Alcohol is often taken in larger amounts or over a longer period than was intended.
2	There is a persistent desire or unsuccessful efforts to cut down or control alcohol use.
3	A great deal of time is spent in activities necessary to obtain alcohol, use alcohol, or recover from its effects.
4	Craving, or a strong desire or urge to use alcohol.
5	Recurrent alcohol use resulting in a failure to fulfil major role obligations at work, school, or home.
6	Continued alcohol use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of alcohol.
7	Important social, occupational, or recreational activities are given up or reduced because of alcohol use.
8	Recurrent alcohol use in situations in which it is physically hazardous.
9	Alcohol use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by alcohol.
10	Tolerance as defined by either the following: (a) A need for markedly increased amounts of alcohol to achieve intoxication or desired effects (b) A markedly diminished effects with continued use of the same amount of alcohol.
11	Withdrawal, as manifested by either of the following: (a) The characteristic withdrawal syndrome for alcohol (b) Alcohol (or a closely related substance, such as a benzodiazepine) is taken to relieve or avoid withdrawal symptoms.
	The presence of at least 2 of these symptoms indicates **Alcohol Use Disorder (AUD)**. The severity of the AUD is defined as: **Mild**: The presence of 2 or 3 symptoms **Moderate**: The presence of 4 to 5 symptoms **Severe**: The presence of 6 or more symptoms

A unit in the UK equates to:

- A single small shot (25 mLs) of spirits ABV 40%
- Beer 250 mLs ABV 4%
- Wine 76 mLs 13%

To work out how many units there are in any drink multiply the total volume of the drink in mLs by its ABV (measured as a percentage) dividing the result by 1000:

Strength (ABV) × volume (mL) ÷ 1000 = units.
So in a pint (568 mL) of lager (ABV 5.2%):
5.2 (%) × 568 (mL) ÷ 1000 = 2.95 units

In the United States, one 'standard' drink contains 14 g of pure alcohol; in Australia a standard drink is any drink containing 10 g of alcohol [159]. Research from the European Union shows a variation between 8–20 g in what is described as a standard drink [160].

Most people who have alcohol in the body have drunk it, although it can be absorbed into the systemic circulation through the lungs (blood alcohol concentrations of up to 50 mg/100 mL have been achieved after breathing alcohol/air mixtures for several hours) [161]. Little or no alcohol is absorbed through the intact skin of adults.

Once ingested, alcohol is subsequently absorbed into the body by a process of passive diffusion that occurs across the mucosal surfaces of the gastrointestinal tract. As liquids pass quickly through the mouth and esophagus, little absorption takes place until alcohol has reached the stomach. The rate of absorption is maximal in the duodenum, because its mucosa is thinner and blood supply more abundant than that of the stomach. Accordingly, any condition that delivers drink into the small intestine more quickly than normal, such as gastrectomy, will lead to more rapid absorption and an earlier, higher peak blood alcohol level.

As soon as alcohol enters the bloodstream, mechanisms for its removal come into action. Some 5–10% of the total amount absorbed is excreted unchanged in breath, urine, and sweat [162], an important factor that allows the estimation of blood alcohol concentrations from the levels in urine and breath. The remaining 90–95% of alcohol is oxidized in the liver by alcohol dehydrogenase to form acetaldehyde, and this is further metabolized to acetate (acetic acid). As alcohol dehydrogenase becomes saturated at relatively low alcohol concentrations, it soon reaches its maximum working rate, and alcohol elimination proceeds at this constant rate [163].

The rate of absorption is very much faster than the rate of elimination, and this fact gives rise to the characteristic blood–alcohol curve, as described by several researchers (Fig. 12.1) [164, 165]. Generally speaking, the peak blood alcohol concentration is reached 30–60 min after drinking, although the range may be anything from 20 min to 3 h. However, the peak blood alcohol concentration, the time taken to reach the peak, the area under the blood–alcohol curve, and the time taken to reach a zero blood alcohol level vary from person to person and within the same person over time [166]. Indeed, a large number of factors can influence the kinetics of alcohol.

Sex and Weight

Alcohol is highly hydrophilic, so once it enters the systemic circulation it is distributed evenly throughout total body water (V_d or the volume of distribution). In general, the larger the person the larger the V_d, so that if two different sized males drink the same quantity of alcohol, a higher peak concentration will be reached in the lighter of the two because he will have a smaller V_d for the alcohol to distribute itself throughout. Similarly, because women have more body fat compared with men, and fat contains no water, higher peak alcohol levels are achieved in women than in men of the same weight. The V_d of alcohol for adult males has been shown to be about 0.70, compared with 0.60 for adult females [162].

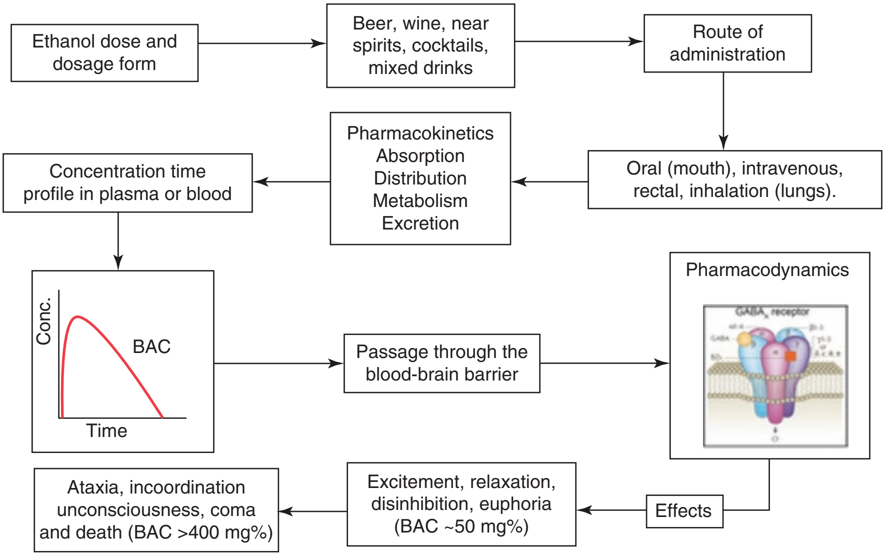

Fig. 12.1 From: Jones AW Alcohol, its absorption, distribution, metabolism, and excretion in the body and pharmacokinetic calculation. WIREs Forensic Sci 2019;e1340

Duration of Drinking

If a volume of alcohol is consumed over a prolonged period, it may be eliminated almost as quickly as it is absorbed, giving rise to a much lower peak alcohol concentration.

Nature of the Drink Consumed

The rate of alcohol absorption increases with the concentration of the ingested solution up until levels of between 10% and 20%, at which point absorption is maximal. Because alcohol is absorbed by passive diffusion, the rate of absorption is slower with drinks of lesser strength because of a lower concentration gradient. Furthermore, the larger volumes involved may also delay gastric emptying and further slowdown absorption. By contrast, when the alcohol concentration of drinks exceeds 20% the alcohol irritates the gastric mucosa and pyloric sphincter, causing increased secretion of mucus and delayed gastric emptying, thus slowing down absorption. Carbonation of drinks may also increase the rate of absorption of alcohol although this effect does seem to be variable [167].

Food in the Stomach

Studies have shown that eating a full meal before drinking can reduce the peak alcohol level by an average of 9–23% [162, 168–170]. The presence of food in the stomach reduces the rate of gastric emptying, dilutes the alcohol that enters the stomach, and limits the contact between the alcohol and the gastric mucosa. Alcohol absorption is slowed for all these reasons.

Physiologic Factors and Genetic Variation

Factors such as stomach wall permeability, blood supply to the alimentary tract, and the rate of gastric emptying will vary from person to person, and from time to time in the same person. All of these will have a bearing on the shape of the blood–alcohol curve.

Drugs

The interaction between alcohol and drugs, either prescribed or illicit, is important because so many detained persons take other drugs in conjunction with alcohol. Generally speaking, the most important interactions involve drugs altering the way a subject responds to a given amount of alcohol in the blood, for example, because the drug has CNS depressant effects that add to those of alcohol. However, a number of drugs may influence the rate of alcohol absorption by virtue of their effect on the rate of gastric emptying (Table 12.14).

Rate of Elimination

The rate of elimination of alcohol has been determined experimentally. Reported values range from about 10 mg/100 mL of blood per hour (mg/dL/h) to 25 mg/dL/h,

Table 12.14 Drugs that affect the rate of stomach emptying and so influence the rate of alcohol absorption

Drugs that slow gastric emptying
Drugs with anticholinergic actions, such as
Atropine
Chlorpromazine
Tricyclic antidepressants
Drugs with an adrenergic action, such as
Amphetamines
Drugs with an opioid action, such as
Antidiarrheal medicines
Codeine and dihydrocodeine
Diamorphine (heroin)
Methadone
Dextropropoxyphene (in co-proxamol)
Drugs that hasten stomach emptying, such as
Metoclopramide
Cisapride
Erythromycin

Adapted from Ferner [161]

with an average of 15–18.6 mg/dL/h [163, 171] (approximately equivalent to the elimination of 1 unit of alcohol per hour in a 70-kg male). Habituation to alcohol is the single most important factor affecting the rate of elimination. One recent study reported the rate of ethanol disappearance in 22 alcoholics as ranging from 13 to 36 mg/dL/h, with an average of 22 mg/dL/h [172]. The increased rate of elimination is thought to be because chronic alcoholics have facilitated liver enzyme systems.

Effects of Alcohol

Alcohol acts as a CNS depressant, which in small doses interferes with cortical function, but which in larger doses may depress medullary processes. The apparent stimulatory effects of alcohol occur because it acts first on the so-called higher centers of the brain that govern inhibition. The signs of intoxication are given in Table 12.15.

While there is general agreement on the sequence of clinical effects caused by drinking alcohol, the blood alcohol concentrations at which these effects occur vary considerably in different subjects. The difference in susceptibility is most marked between habituated and non-habituated drinkers, but tolerance to the effects remains very variable even within these broad categories [173, 174]. Table 12.16 provides a guide to the general effects. It should be noted that the effects are more pronounced when blood alcohol levels are rising than when falling. This is known as the Mellanby effect and is thought to be due to an acute tolerance to alcohol that develops during intoxication [175]. Some specific effects are discussed below.

Table 12.15 Signs of alcohol intoxication

• Disinhibition/labile effect;
• Sedation;
• Concentration/attention/memory difficulties;
• Smell of alcoholic liquor;
• Tachycardia;
• Hypertension;
• Flushing;
• Nystagmus;
• Pupil size—may be normal or dilated;
• Sluggish pupillary reaction to light;
• Poor co-ordination;
• Romberg's positive;
• Ataxia.
Severe intoxication/overdose
• Alteration in mental state;
• Hypoglycaemia;
• Respiratory depression;
• CNS depression (coma with pin-point pupils);
• Depressed or absent corneal, gag or deep tendon reflexes;
• CVS depression.

Table 12.16 Sequence of central nervous depressant effects of alcohol

Stage of influence	Blood alcohol concentration (mg/100 mL)	Clinical effect
Sobriety	10–50	Often no obvious effect
		May feel "relaxed"
Euphoria	30–120	Mild euphoria with increased talkativeness
		Decreased inhibitions
		Increased self-confidence
		Impaired fine motor skills
Excitement	90–200	Emotional instability
		Poor sensory perception
		Impaired memory and comprehension
		Incoordination and loss of balance
Drunkenness	150–300	Disorientation, mental confusion
		Disturbances of vision (e.g., diplopia)
		Decreased pain sense
		Increased incoordination with staggering gait
		Slurred speech
Stupor	250–400	General inertia approaching paralysis
		Marked lack of response to stimuli
		Inability to stand or walk
		Vomiting, incontinence of urine and feces
Coma	350–500	Coma and anesthesia
		Depressed or absent reflexes
		Cardiovascular and respiratory depression
		Possible death
Death	Over 450	Death from respiratory depression

Nystagmus

As the eye is effectively part of the CNS, it is one of the easiest parts of the body to examine in order to detect the effects of alcohol; the most extensively studied ocular effect of alcohol intoxication is nystagmus. Alcohol can cause nystagmus through at least two mechanisms. By acting on the vestibular system, it can cause positional alcohol nystagmus (PAN) [176], detected when the patient is lying supine with the head turned to either the left or right. Horizontal gaze nystagmus (HGN) results from the inhibition of the smooth pursuit system and the impaired ability to maintain eccentric gaze [177] brought about by alcohol's effect on ocular movements via neural mechanisms [178].

PAN occurs in two stages [179]. The first stage, PAN I, is associated with acute elevation of blood alcohol, tending to occur about 30 min after alcohol ingestion. In PAN I the fast phase of nystagmus is in the direction toward which the head is turned. PAN II normally occurs at about 5–6 h after drinking and is characterized by nystagmus in the opposite direction to that seen in PAN I.

HGN is a jerky eye movement noted when gaze is directed to one side. The fast phase of HGN is in the direction of gaze, and it becomes intensified at a more eccentric gaze position [178]. Although HGN can be seen in normal individuals at extreme lateral gaze [180], when detected at lesser deviations it is considered pathologic. An angle of onset of 40° or less from the midline has been found to be a sensitive indicator of a blood alcohol level in excess of 100 mg/100 mL [178]. While some authors have maintained that blood alcohol levels of over 80 mg/100 mL are consistently associated with HGN [181], others have found that it is absent in just under 40% of drivers with an average blood alcohol of 120 mg/100 mL (range 9–218 mg/100 mL) [182]. As HGN may be noted in a number of pathologic conditions including the ingestion of sedative and tranquilizing drugs [183], its presence should not be taken as proof of alcohol intoxication, especially as evidence in cases of driving while intoxicated (DWI) [184]. It is perhaps for these reasons that the Kansas Supreme Court, when assessing the admissibility of HGN evidence in drink driving prosecutions, decided that "the reliability of HGN evidence is not currently a settled proposition in the scientific community" [185].

Pupillary Changes

In the early stages of alcoholic intoxication, the pupils are said to dilate, often becoming pinpoint as the level of intoxication advances, particularly when the state of coma is reached [186]. However, some commentators report the pupils as being normal-sized in alcohol intoxication [187], with current advice favoring the view that pupil size may be normal or dilated.

Alcohol may slow the pupillary response to light, such an effect being one of the more reliable eye signs of intoxication albeit a difficult one to detect clinically.

Slurred Speech

Speech production is a complex motor activity. As it requires a high degree of coordination, it can be a sensitive index of alcohol intoxication [188]. Reliable changes in speech are produced at blood alcohol levels above 100 mg/100 mL [189], although the effects of lower blood alcohol levels have been variable.

Cardiovascular Effects

Moderate doses of alcohol cause a slight increase in blood pressure and pulse ate, [190, 191]. However, the most prominent effect with higher doses is a depression of cardiovascular functions. This depression is probably a combination of central effects and direct depression of the myocardium [175].

Metabolic Effects

HCPs need to be aware that severe hypoglycemia may accompany alcohol intoxication because of inhibition of gluconeogenesis. Alcohol-induced hypoglycemia, which develops within 6–36 h of heavy drinking, typically occurs in an undernourished individual or one who has not eaten for the previous 24 h. The usual features of hypoglycemia, such as flushing, sweating, and tachycardia, are often absent, and the person may present in coma.

Death from Alcohol Poisoning

Alcohol intoxication may result in death due to respiratory or circulatory failure or as a result of aspiration of stomach contents in the absence of a gag reflex. Levels of blood alcohol above 500 mg/100 mL are considered to be "probably fatal" [192], although survival at much higher concentrations is now well documented. In 1982, for example, the case of a 24-year-old woman with a blood alcohol level of 1510 mg/100 mL was reported. She had gone to the hospital complaining of abdominal pain and was noted to be conscious but slightly confused. Two days later her pain had eased, her blood—alcohol level fallen, and she was able to leave the hospital and return home [193].

Death associated with blood alcohol levels below 350 mg/100 mL suggests that other complicating factors are present. Most commonly this will be an interaction between alcohol and some other drug that has also been ingested.

Diagnosis of Intoxication

The terms alcohol intoxication and drunkenness are often used interchangeably. However, a distinction between these terms is justified as people may exhibit behavioral changes associated with drunkenness when they believe they have consumed alcohol but actually have not [194] (Table 12.17).

Alcohol Dependence

Alcohol use disorder is a major risk factor for serious health, social, and economic problems [196]. Early identification of those who are dependent on alcohol increases the possibility of successful treatment [197] and brief intervention by the HCP seems both feasible and acceptable [198].

It is essential that custody staff ensure that those who are identified on risk assessment with an alcohol problem and/or are suspected of being dependent on alcohol should call a HCP to fully assess the detainee, and whether in view of the proposed length of detention, early treatment is required to prevent the major complications of withdrawal (see below).

Table 12.17 Differential Diagnosis of Alcohol Intoxication [195]

Differential diagnosis	Clinical marker(s)
Other Intoxicants	
Drugs of abuse Cocaine/Amphetamines-type stimulants Opiates Prescribed medication: benzodiazepines, anti-psychotic medications	Personal history of use Information from police (National computer database) Drug possession/drug paraphernalia identified during police search (e.g. citric acid) Disproportionate mental stimulation Injection marks, excessive sedation Medications found/prescriptions, hospital appointment cards
Infections (Sepsis)	History/Examination for source of infection Pyrexia Meningism
Head injury	History of head injury, particularly at time of arrest Visible head injury Localising neurological signs
Metabolic causes Hypoglcaemia Hyperglycaemia/diabetic ketosis	MEDIC ALERT bracelets Blood glucose measurement Blood glucose measurement/urinalysis for ketouria
Other electrolyte disturbance	Diuretic use, other comorbid conditions (cancer, heart failure etc.)
Hepatic encephalopathy	Signs of chronic liver disease, ascites
Other	
Seizures/post-ictal states Acute psychiatric conditions Hypoxia/hypercapnia	Confusion/disorientation Abnormal mental state examination Pulse oximetry

However, obtaining accurate and reliable information about a person's drinking habits can be extremely difficult. The use of an alcohol screening questionnaire is essential in identifying alcohol problems [199]. The Alcohol Use Disorders Identification Test (AUDIT) identifies persons whose alcohol consumption has become harmful or hazardous to health [200] and is probably the best screening instrument in this environment [201]. This can be used in combination with the Severity of Alcohol Dependence Questionnaire (SADQ) [202].

Alcohol Withdrawal

All HCPs working in the custody environment should be skilled in the assessment of detainees with AUD, including alcohol withdrawal. Detainees with marked alcohol dependence may develop withdrawal symptoms before the alcohol level is zero. Alcohol withdrawal symptoms and signs include: agitation, tremor, sweating, fever, tachycardia and hypertension. Complications of severe withdrawal include seizures, hallucinations, confusion, disorientation, aggressive behaviours and delirium tremens. The use of a tool such as Clinical Institute Withdrawal Assessment for Alcohol (CIWA) [203] is recommended. The severity of the symptoms depends mainly on the amount and duration of alcohol intake, although other factors, such as concurrent withdrawal from other drugs, such as benzodiazepines, may contribute to the clinical picture. Detainees at high risk, with a past history of severe withdrawal with seizures or previous delirium tremens should be transferred to hospital. Treatment should be given using a long acting benzodiazepine in custody, such as diazepam or chlordiazepoxide. A symptom-triggered regimen for drug treatment for people in acute alcohol withdrawal should only be used in hospital or in other settings where 24-h assessment and monitoring are available [204].

Alcohol Withdrawal Delirium

The essential diagnostic feature of this disorder is a delirium that develops after recent cessation of or reduction in alcohol consumption. Traditionally referred to as delirium tremens, this withdrawal state typically begins 72–96 h after the last drink, so it is uncommon within the normal span of detention in police custody. However it may occur earlier (after 24 h). The delirium is characterized by impaired attention and memory, disorganized thinking, heightened suggestibility, disorientation, reduced level of consciousness, perceptual disturbances, and agitation. Vivid, and often terrifying, hallucinations may occur. Usually these are visual, but other sensory modalities (e.g. auditory or tactile) may be involved. The disorder usually coexists with other features of alcohol withdrawal, for example, autonomic hyperactivity, which is usually severe. Alcohol withdrawal delirium is a medical emergency with a mortality rate of about 5%. Once diagnosed, the detained person with delirium requires urgent hospitalization.

Withdrawal Seizures

Seizures are typically single and generalized. They tend to occur between 6 and 48 h after the last drink and while they are not life threatening, their importance lies in the fact that about one third of those with seizures will go on to develop alcohol withdrawal delirium.

Alcoholic Hallucinosis

The essential features are auditory or visual hallucinations, which develop either during or after a period of heavy alcohol consumption.

Cardiac Arrhythmias

The frequency of tachyarrhythmias in alcohol withdrawal is high, probably because of high adrenergic nervous system activity. Sudden deaths in alcohol withdrawal are most likely due to such dysrhythmias. Adequate sedation will play a part in preventing such unwanted occurrences happening in police custody, although those with severe alcohol withdrawal are best admitted to the hospital, where they can be placed on a cardiac monitor.

Wernicke's Encephalopathy and Korsakoff's Psychosis

Wernicke's encephalopathy is a medical emergency which may be precipitated by alcohol withdrawal, or intercurrent illness, such as sepsis. Features include disturbance of consciousness (ranging from mild confusion to coma), double vision, ophthalmoplegia, nystagmus, and ataxia. The disorder is due to a poor intake, or absorption of, thiamine and has a high mortality (up to 20% in the acute stage). Korsakoff's psychosis often emerges as a chronic disorder after an episode of Wernicke's encephalopathy. This usually presents as impairment of short-term memory with inability to learn new information and compensatory confabulation. Korsakoff's psychosis probably represents irreversible brain damage secondary to the combined toxicity of alcohol and metabolic derangement due to thiamine deficiency.

Memory Problems Associated with Alcohol

'Blackouts' associated with use of alcohol suggests transient memory loss which may be induced by intoxication but there is no loss of consciousness. There is a significant association between the BAC and the level of amnesia reported. As the BAC increases the likelihood of complete memory loss (blackout) or fragmentary memory loss (grayout) increased [205].

Detainees who have severe AUD may have a form of dementia with mild to moderate impairment of short- and long -term memory.

Key Points

- The management of detainees with substance use disorders can be challenging in the custody environment. HCPs should be aware of drug trends in their area of practice.
- Early assessment and prompt treatment of alcohol dependent detainees is essential to prevent the complications of withdrawal.
- If drug facilitated crime, including and drug facilitated sexual assault, is suspected the appropriate forensic samples should be taken.
- Detainees are entitled to have their prescribed medication continued in custody as long as it is clinically safe to do so. This includes opiate substitution treatment such as methadone or buprenorphine.

Self-Assessment Exercises

1. List the symptoms and signs of stimulant intoxication?
2. How would you treat gamma-hydoxybutyrate (GHB) withdrawal in custody?
3. What is the half-life of methadone? How does this inform the need for treatment?
4. What is Korsakoff's psychosis and how should it be treated?

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Deaths in Police Custody

13

Richard T. Shepherd

Learning Objectives
Outline the main causes of death in police custody.
Describe acute behavioral disturbance and excited delirium.
Demonstrate the ability to verify life extinct.
Understand the requirement of a death in custody investigation.

Introduction

Healthcare Professionals (HCP) will, in all probability, have to deal with a death in police custody at some point in their career. This chapter aims to provide a broad basis for the understanding of the disease processes, the mechanisms that may lead to death, and also to outline the current thinking behind deaths associated with restraint.

Definition

When considering any death associated with detention by officials of a state, caused by whatever means, each state will define, according to their own legal system, the situations that are categorized as being "in custody" [1]. The worldwide variation in these definitions continues to cause considerable confusion in any discussion of this subject. For the purposes of this chapter "in custody" relates to any individual who is either under arrest or otherwise under police control and, while similar deaths may occur in prison, on psychiatric wards or in other situations where people are detained against their will, it is the deaths specifically associated with police detention that will form the basis for the discussion here.

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Having defined the broad parameters of the subject, it is important to distinguish between the different types of custodial deaths since it is deaths that are related to direct police actions (acts of commission) that seem to cause the greatest concern to the family, the public and the press. It is also important to remember that police involvement in the detention of individuals extends beyond direct physical contact and includes a "duty of care" to that individual and any "lack of care "in this situation may be termed "act of omission". Lack of police action, or "care", has also been responsible for deaths in custody. These acts are considerably harder to define and sometimes result from the police being placed in, or assuming, a role of caring (for instance, in states of alcoholic intoxication or acute psychiatric conditions) that are beyond their competence or which they are not equipped or trained to fulfil.

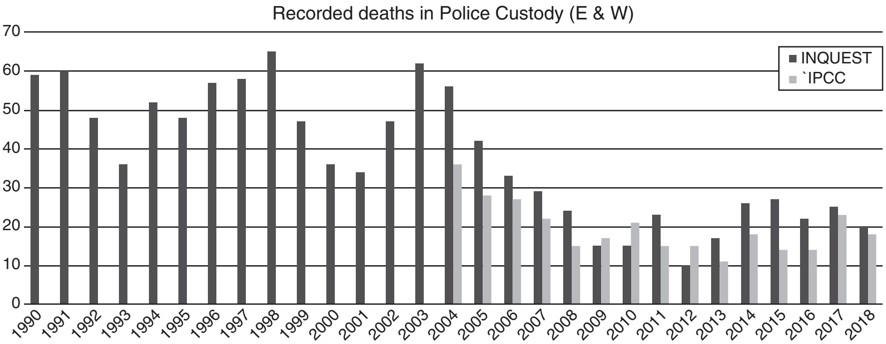
Police involvement with an individual can also include those who are being pursued by the police either on foot or by vehicle, those who have been stopped and are being questioned outside the environment of a police station, and those who have become unwell through natural causes while either in contact with, or in custody, of the police.

The definitions of "death in custody" are therefore wide, and attempts at setting definitions that cover all aspects of such deaths are fraught with difficulty. Any definition will have to cover a multitude of variable factors, in various circumstances and with a wide variety of individuals [2, 3]. The crucial point is that, in a civilized society, the police owe a duty of care to each and every member of the public with whom they have contact and it is essential that every police officer, whether acting or reacting to events, understands and is aware of the welfare of the individual or individuals with whom he or she is dealing.

Statistics

The lack of a standard international definition of "death in custody" means that the simple comparison of the published raw data from different countries is of limited value. The number of deaths in police custody in England and Wales from 2004 to 2018 recorded by Dame Angiolini's report [2], INQUEST [4], and the Independent Office of Police Conduct (IOPC), previously known as the Independent Police Complaints Commission (IPCC) [5], shows considerable variation year on year, and also between the different data sets (Graph 13.1). This data must be treated with considerable care since any changes in the death rates may not be the result of changes in the policy and practice of care for detainees but other, undetermined, factors such as increases or reductions in arrest rates over the period as a result of changes in local policing procedures or central governmental policy.

The National Deaths in Custody Program (NDICP) has monitored deaths occurring in prison, police custody and youth detention in Australia since 1980. The Australian Institute of Criminology (AIC) has coordinated this program since its establishment in 1992 following a recommendation of the Royal Commission into Aboriginal Deaths in Custody (RCIADIC). The most recent figures from 2016 to



Graph 13.1 Deaths in police custody in England & Wales

2017 show that 17 deaths occurred in police custody and custody-related operations. Most deaths in police custody in 2016–2017 resulted from external trauma injuries and gunshot wounds (n = 5 each); four were self-inflicted, four were the result of a justifiable homicide, four were accidental, three resulted from natural causes, and two had an 'other' or unknown manner of death [6].

By comparison, and looking more closely at one published set of statistics, those from the IOPC, investigating deaths in police custody in England and Wales in 2017/2018, fatalities were noted in the following categories [7]:

- 29 road traffic fatalities
- 4 fatal shootings
- 23 deaths in or following police custody
- 57 apparent suicides following police custody
- 170 other deaths following police contact that were subject to an independent investigation

It is concerning that the number of deaths in, or following, police custody, has increased to 23 which is the highest figure recorded in 10 years. From 2004/2005 to 2008/2009, there was a year-on-year reduction in the number of deaths in or following police custody from 36 deaths in 2004/2005 to 15 deaths in 2008/2009. Over the next 2 years, the number of deaths in custody increased to 21 in 2010/2011, before falling back to 15 in 2011/2012 and 2012/2013. There was a further reduction, to 11, in 2013/2014. In 2014/2015, the number rose again to 18 and deaths following apparent suicide rose, although this increase is in part the result of improved identification of cases.

The Home Secretary (UK) in July 2015 announced that an independent review into Deaths in Custody was to be carried out by Dame Elish Angiolini QC [2]. The report of this review, published in 2017, made 110 recommendations on a variety of

Table 13.1 Themes in causes of death in police custody

• Drugs, alcohol, mental health—co-morbidities
• Missed drug swallowing
• Intoxication—actual level and masking other medical issues (and with time withdrawal)
• Failure to perform an adequate risk assessment—risk factor in itself
• Failure around the checks and rousing by custody staff
• Consider restraint
• Written and verbal handover to custody staff by HCPs (communication)

areas including: restraint, custody environment, health and wellbeing, funding for families and family support, communications, investigations, coroners and inquests, accountability, training, learning, statistics and research.

Natural causes have been the most common known cause of deaths in police custody in England and Wales between 2004/2005 and 2014/2015, accounting for 51% of causes of death in this period. Drugs and/or alcohol also featured as in the causes of death in around half of deaths (49%), and an even higher proportion of those who died had an association with drugs or alcohol (82%). A significant number of themes have been identified (Table 13.1).

Investigation of Deaths in Custody

Legal Framework

In England and Wales the death of any individual who is detained in prison or under the Mental Health Act must be reported to the Coroner, however if the individual is detained by a police officer in a public place, a police vehicle or in a custody suite then there is no obligation to report the death to HM Coroner although in practice all such cases are referred. The Home Office has recommended [8] that all deaths falling into even the widest definition of "in custody" should be subject to Coronial Inquest [9] and hence a full inquiry into the facts and a full postmortem examination should be performed. In the UK Article 2 (The Right to Life) of the European Convention of Human Rights is invoked which accepts that all deaths occurring in custody should be fully investigated and considered by the legal system. However, not every country will follow this, and some local variations can and do occur outside the European Union, this is particularly so in the USA.

Protocol

No standard or agreed protocol has been devised for the postmortem examination of these deaths and, as a result, variation in the extent of the examination and the subsequently reported details is to be expected. A general Code of Practice and performance standards for Forensic Pathology [10] has been published and any pathologist considering performing an examination of a death in custody would be well advised to consider that document with care before proceeding. Despite this, the differences in the procedures and the number and type of the specialist tests performed inevitably results in considerable variation in the pathological detail available as a basis for establishing the cause of death and hence available for presentation at any subsequent inquest or criminal proceeding. The absence of a defined protocol hinders considerably the analysis of the results of these examinations and makes even the most simple comparisons unreliable. There is always a need for a properly established academic study of all of these deaths, such as that performed by Lindon and Roe [1] in 2014 for the UK government. As a joint venture by Department of Health, Department of Justice and the Home Office, the Independent Advisory Panel on Deaths in Custody was constituted to inform and advise the joint Ministerial Board on Deaths in Custody [11].

In the UK, the IPCC was replaced by the IOPC in January 2018. The IOPC continues to have a major role in the management of the investigations of all deaths in custody and it also investigates many of the more serious complaints, including allegations of misconduct against the police in England and Wales. Other jurisdictions will have similar investigative organizations: The Police Ombudsman of Northern Ireland (PONI) investigates deaths in custody (https://www.policeombudsman.org/Home). In Scotland the role of the Police Investigations and Review Commissioner (PIRC) was introduced in 2013 when the police service of Scotland was established (https://pirc.scot/about-us/).

Terminology

In addition to the lack of reproducibility of the postmortem examinations, the terminology used by the pathologists to define the cause of death, particularly in the form required for the registration of the death, may often be idiosyncratic, and similar disease processes may be denoted by different pathologists using many different phrases. For example, damage to the heart muscle caused by narrowing of the coronary arteries by atheroma may be termed “Ischemic Heart Disease” or it may be called “Myocardial Ischemia due to Coronary Atheroma” or even rarely by the “lay” terminology “Heart Attack” [10]. This marked variation in terminology may often lead to confusion, particularly among lay people, attempting to understand the cause and the manner of death. Much research [3, 12] has been produced based upon such lay assessments of the pathological features of a death and this has, at times, resulted in increased confusion rather than clarification of the issues involved.

If the issues regarding the definition of “in custody”, the variation in the postmortem examinations, the production of postmortem reports, and the analysis of subsequent specialist tests, all raise problems within a single country, then the consideration of these deaths internationally produces almost insuperable conflicts of medical terminology and judicial systems.

Deaths Related to the Phases of the Police Custodial Process

In an attempt to add some clarity to the situation, it is possible to state that whatever national definition of "in custody" is used, a number of phases of the custodial process can be identified and the types of deaths which occur during these different phases can be analyzed. Clearly a death, either sudden or delayed, may occur for many different reasons even in the absence of police but since it is the involvement of police that is the *sine qua non* of "in custody" deaths, the first phase must be considered to be the presence of police officers at the scene. Subsequently, an arrest may be made with or without the use of restraint techniques and the prisoner will then be transported to a police station.

This transport will most commonly involve a period within a police vehicle which may be a car, a van with seating or some other vehicle. Many factors may determine the type of transport used and the possible positions of the individual with the vehicle. Arrival at the police station will be followed by various assessments initially by non-medical personnel and decisions will be made regarding detention. Healthcare professionals (HCPs) may become involved, immediately or later, in the decision making process regarding fitness of the individual to be detained.

Detention in a police station will be followed by a period, or periods, of interview interspersed with periods of time incarcerated, usually alone, within a cell. Following interview the individual may be released with no further action/under investigation, they may be charged and then released or charged and detained to appear before a court. It is at this point that custody moves from the Police to other authorities, usually to the prison service.

When considering the types of death that can occur during each of these phases, six main groups can be identified based on the reported causes of death. The groups are:

- Natural deaths
- Deaths associated with accidental trauma
- Deaths related directly to the use of alcohol
- Deaths related to the use of other drugs
- Deaths associated with self-inflicted injury
- Deaths associated with injuries deliberately inflicted by a third party

It is clear that different factors may lead directly to, or play a major part in, the death of an individual while in custody and that different factors will play their part at different phases in the period of custody (see Table 13.2).

Acute alcohol intoxication or the deleterious effects of drugs are, in most cases, likely to have a decreasing effect with time as they are metabolized or excreted from the individual's body. They are therefore most likely to cause death in the post arrest and early detention phases and it is important to note that their effects will be least visible to those with the "duty of care" while the individual is out of sight, detained within a cell—particularly if they are alone within that cell. Similarly the effects of

Table 13.2 Expected types of deaths in different phases of custody

	Natural	Accidental trauma	Alcohol	Drug	Self-inflicted	Deliberately inflicted
Pre-arrest	++	+++	++	++	±	±
Arrest	++	+++	++	++	±	+++
Detention	+	+	+++	+++	++	++
Interview	+	+	++	++	+++	+
Charge	+	+	–	–	+++	±

trauma, whether accidentally or deliberately inflicted, are most likely to become apparent in the early phases of detention and it would only be on rare occasions that the effects of such trauma would result in fatalities at a later stage although this has occurred on several occasions in particular with head injuries [13]. Conversely death resulting from self-inflicted injuries are unlikely to occur in the pre-arrest and the arrest phases of detention but can and do occur when the individual is placed in a cell and is not under immediate and constant supervision. Cell design has improved notably with the removal of potential ligature points along with the increasing use of monitoring by CCTV, but unless the detainee is constantly supervised opportunities may still arise to self-harm.

Deaths from natural causes on the other hand can occur at almost any time during the period of arrest and detention. It is possible that the stress (whether emotional or physical or both) associated with the initial phases of arrest and with the subsequent, more emotionally stressful phases during detention are likely to precipitate the death of the susceptible individuals through the effects of sympathetic stimulation and the release of adrenalin. Deaths from natural causes should be reduced by the clinical assessment of this vulnerable group of patients by competent HCPs with the appropriate knowledge, skills and experience. Custody staff must also ensure proper supervision of detainees from the time of their initial arrest and throughout the period of detention (see Chap. 9).

It is, however, quite clear that the deaths described in many reports are not "pure" i.e. they are not attributable to any one single category. Individuals with heart disease may also be under the influence of alcohol; individuals under the influence of alcohol or drugs may also have suffered trauma, either accidental or deliberate, prior to or during their detention. In determining the cause of death it can therefore be extremely difficult to give weight to each of the factors that could be identified during the period of detention. There is clearly great need for early assessment and accurate diagnosis of natural disease (physical or psychiatric), of alcohol or drug intoxication or withdrawal, and for the identification, documentation, and treatment of all types of trauma.

The removal of an individual's freedom places upon the police a duty of care to that individual and it is only by the active assessment of each and every person entering police custody and the continuing care of that individual that the number of deaths in custody can be reduced.

Causes of Death

Natural Causes

Apart from a few unusual cases, deaths due to natural causes while in police custody fall into the groups of disease processes that are commonly associated with sudden natural death in the community.

Cardiovascular Disease

The most common cause of death in the community and of sudden death in particular, is cardiac disease, and within this group those deaths recorded as being due to ischemic heart disease or coronary atheroma are the most common. The exact definitions and criteria for the pathological diagnosis of significant ischemic heart disease [14] are not within the scope of this chapter. While there is a clear increase in the incidence of this cause of death with age [15], it is important to remember that a small percentage of people in the younger age groups, most commonly those with hypercholesterolemia and hyperlipidemia, may also have significant coronary artery disease and since it is the younger age groups that are more likely to be arrested by the police these few individuals may assume great significance.

The significance of coronary atheroma is that individuals with this disease are particularly prone to the development of dysrhythmias during periods of stress when the adrenaline-induced tachycardia results in a decreased ability to perfuse areas of the myocardium during diastole which may result in the development of ischemic ectopic electrical foci. Deaths may be preceded by the development of classical cardiac chest pain or it may present with sudden collapse and death without prior warning.

Individuals suffering from significant myocardial hypertrophy due to chronic hypertension are also at greater risk during periods of stress. Once again it is the older age groups that are most commonly affected by essential hypertension which may also render these individuals susceptible to focal lack of myocardial perfusion during periods of tachycardia. In addition to these two disease processes, there are also the much rarer diseases or syndromes that may cause sudden death which are possibly more significant in the context of "deaths in custody" since some of them tend to affect younger age groups in particular. Congenital valvular disease (e.g. floppy mitral valve disease) and congenital myocardial disease (e.g. the cardiomyopathies) may both render an individual more susceptible to sudden cardiac death and, as with ischemic or hypertensive heart disease, sudden death is more likely when the sympathetic stimulation which is associated with stress, (emotional and/or physical) has resulted in tachycardia.

Genetic research has now identified a genetic basis for many other sudden cardiac deaths in the younger age groups. These genetically mediated disease processes (for example, the prolonged QT syndrome) are often known by the generic term "channelopathies" and can sometimes be diagnosed in life by ECG, however after death their presence and hence their possible relationship to the sudden death, can be inferred only from the detection of specific gene defects [16]. The examination for these specific gene markers in any sudden death in police custody must now be considered essential especially in the absence of other causes of death.

Myocarditis and rheumatic heart disease are rare causes of death in young individuals although such deaths may occur without any prior indication of a disease process in individuals in police custody and elsewhere.

Other cardiovascular causes of sudden death are also, for the most part, age related. The rupture of atheromatous aortic aneurysms is a disease almost entirely confined to late middle and old age while the rarer forms of aortitis and collagen diseases of the aorta [17], which may also result in rupture, are more commonly seen in the younger age groups. The diseases that are not age related may be associated with a long history of alcohol or drug abuse and the long term effects may result in alcoholic cardiomyopathy, cocaine-related myocardial scarring, or other coronary artery or myocardial effects that can result in a sudden death even after long-term abstinence from, or just short-term lack of, alcohol or the preferred drug(s) of abuse.

Pulmonary emboli can cause sudden death or they may present as dyspnea and chest pain. It is most unusual for deep venous thrombosis of the leg veins to be present in a young active male; however, the association between some types of the combined oral contraceptive pill and the development of thromboses has been known for some time [18] and may render a small subgroup of the female population at greater risk of pulmonary emboli than the general population.

Central Nervous System

The stress associated with arrest and detention in custody may also have significant effects upon the cerebro-vascular system and may, in susceptible individuals, precipitate intracerebral hemorrhage by the rupture of congenital or acquired aneurysms or from other vascular malformations. Ruptured “berry” aneurysms will result in the development of acute subarachnoid hemorrhages. It is less likely that these intracranial hemorrhages will result in sudden death but they may result in sudden unconsciousness which leads ultimately to death. Clearly the distinction between hemorrhage due to a natural disease process and that due to trauma will need to be established and a specialist neuropathological examination will be required should death occur.

As with the heart, the possibility that an infectious process within the central nervous system is the cause of sudden collapse and death must be considered. It is however unlikely that meningitis or encephalitis will present without any prodromal symptoms. Epilepsy is unlikely to develop de novo following arrest and detention but epilepsy can, and does, lead to sudden collapse and death and a pre-existing history of epilepsy is clearly important. Any individual known to suffer from epilepsy should be monitored with the utmost care and their prescribed medication continued.

Other forms of intracranial pathology that may lead to sudden death include tumors, both benign and malignant, and such rarities as the development of colloid cysts of the ventricular system.

Endocrine

Diabetes mellitus should raise similar concerns to those associated with epilepsy since poorly controlled diabetes may on occasions be the direct cause of sudden death. Diabetes generally, through its association with an increased incidence of arterial disease, is a major factor in the development of coronary artery disease in the younger age groups. At postmortem consideration must be given, in all cases of sudden death in a young individual but particularly when there is a history of diabetes mellitus, to the sampling of the vitreous humor in an attempt to determine the blood glucose level at the time of death. The samples need to be taken as soon after death as possible to avoid postmortem utilization of the intraocular glucose yielding erroneous results [13].

Other Causes

There are many other natural disease processes that could theoretically lead to sudden collapse and death. Amongst these is asthma, a disease that is usually unlikely to lead to sudden death if adequately treated and supervised but which may, if untreated and unsupervised and in stressful circumstances, result in the individual being found dead in their cell. Other disease processes include the development of hemoptysis, from tuberculosis or pulmonary malignancy, or hematemesis, from peptic ulceration or esophageal varices, which can be life threatening and which may, because of the bleeding, be considered to be the result of trauma rather than a natural disease process. These cases should present no problem to an experienced pathologist following a full postmortem examination.

Conclusion

The significant feature when considering possible natural causes of death of an individual in police custody is that some diseases can lead to rapid collapse and death with no prior warning in a young individual who is apparently fit and well immediately prior to the collapse. There is no method that the police can use to determine which of the individuals they encounter will be suffering from these diseases or from a genetic abnormality that may lead to electrical disturbances within the myocardium. Indeed many of these disease processes can only be diagnosed after complex medical testing following the taking of a full medical history.

The fact that many of these diseases are rare in the age group that is most likely to be detained in custody places additional burdens upon the police officers required to care for these individuals and also upon the HCPs required to examine and treat them in the police station. The difficulties that these cases present to the pathologist lies in the need to have an awareness of all of the possible natural causes of sudden death and the need for a careful determination, and if necessary exclusion, of all of these causes—cardiac, neurological, endocrine etc., before forming the conclusion that some other factor has resulted in death.

Accidental Trauma

It is clear that determining if trauma is the result of an accident or not, may depend on the “eye of the beholder”. As an example of this it is impossible at postmortem to determine if the injuries caused following a fall from a window during arrest were the result of an accidental fall, an intended jump, or a deliberate push from that window since any points of contact with the building during the descent and the contact with the ground will result in the same injuries whatever the initial “cause”. Pathologically the only features of relevance in determining the exact cause of the initiation of the descent are the identification of specific gripping, holding or other restraining injuries that could have occurred prior to the descent or the identification of marks or injuries that may or may not be present (for instance to the fingers) that could be ascribed to attempts to hold on to a window ledge etc. All of the injuries or marks found on the body will have to be correlated with witness statements both from the police and from any other parties present at the time of the fall. Often the true interpretation of many of the injuries and marks found during the postmortem will only become clear when these statements are considered.

In general terms, however, accidental trauma can be caused by many events during the course of an arrest. Falls onto the ground may occur from a height or from standing. Gripping and restraining injuries are commonly present on many areas of the body but are likely to be most common on the arms. The site and significance of the injuries present will depend on the descriptions of the events before, during and after the arrest.

It is essential that all injuries, no matter how apparently trivial, present on a detained individual are carefully documented by the HCP who examines the detainee whether at a police station or elsewhere. Contemporaneous photographs are always extremely helpful in these circumstances and all injuries should be photographed both with and without a measuring scale (see Chap. 4). The ageing of bruises is fraught with difficulties and the documentation of any observed colors and the changes of colors in bruises by the HCP can be of importance. However many factors such the nature of the light (natural, fluorescent, etc.) in which the injuries are viewed may cause significant apparent differences and in addition inter-observer variations may render simple verbal descriptions less reliable. Careful photography with the mandatory inclusion of a standard color strip in the photographs is essential if later review of color is to be if any value.

In terms of a cause of death few of the minor injuries will be relevant but they may provide an indication of the extent and degree of the force that was applied to effect an arrest and, as such, they can be of immense value. Injuries present in sites that are known to be of high risk, for instance around the neck, must be examined, documented and interpreted with particular care. All of the injuries need to be interpreted in the light of witness statements and can provide very useful corroborative evidence.

Alcohol and Drug Related Deaths (See Chap. 12)

Alcohol

Alcohol is one of the most commonly used drugs in the world. The small ethyl alcohol molecule can pass easily through the blood–brain barrier to the CNS where it has direct suppressant effects on the whole of the central nervous system. At low concentrations the specialized cells of the cerebral cortex are affected but as the concentration increases the depressive effects involve the higher areas of the brain resulting in increasingly disinhibited behavior. Still higher levels of alcohol result in the depressant effects involving the lower levels of brain function, including the vital cardiorespiratory centers in the midbrain and the medulla, predisposing the intoxicated individual to cardiorespiratory depression or arrest. Alcohol levels in excess of 300 mg/dL are considered to be potentially lethal although some individuals have survived, usually with medical attention, with far higher levels. Some, it must be remembered, have died with far lower levels of alcohol in their blood stream.

The effects of alcohol are however not confined to the brain, there is also marked peripheral vasodilation resulting in increased heat loss which may, on occasions, lead to hypothermia. The adverse effects of alcohol on the coronary circulation, particularly when associated with significant coronary atheroma may lead to myocardial ischemia and the development of dysrhythmias and sudden death.

Alcohol also has marked diuretic effects and when combined with the ingestion of large quantities of fluid (particularly in beer and lager drinking) this may result in electrolyte disturbances particularly hyponatremia.

The chronic effects of alcohol involve many of the internal organs; alcoholic cardiomyopathy, hepatic steatosis and cirrhosis are the most common and all can lead to sudden death.

Alcohol may also be a major factor in causing death by predisposing the individual to accidental trauma and by obscuring the effects of that trauma [13, 19]. This is particularly the case in head injuries when the changes in conscious level are attributed to the effects of alcohol rather than an identified or unidentified head injury.

Alcohol is also a gastric irritant and may precipitate vomiting when taken in excess. This, combined with the effects of decreased consciousness and the reduced laryngeal reflexes associated with intoxication, result in a significantly increased risk of aspiration of vomit into the airways and death. Such an event is unpredictable and, without constant supervision, unpreventable.

The anesthetic effects of alcohol may also result in deaths from asphyxiation. These deaths are the result of the intoxicated individual moving into, or being placed or left, in a position that impedes respiration either by occlusion of the external respiratory orifices, the internal airways (particularly the larynx), or restricts the free movement of the chest wall. These positions may result from lying face down on a bed, marked extension or flexion of the neck or lying across an edge with the head down. Deaths resulting from impairment of respiration in this manner classically result in profound asphyxial changes involving the upper body and these deaths are ascribed to postural asphyxia.

The metabolism of alcohol follows pathways that results in temporary increase of toxic chemicals including ketones (acetaldehyde, β-hydroxybutyrate etc.) in the blood. These metabolic products result in raised blood acidity and cause further disturbances in sodium/potassium, glucose and other metabolic pathways. If the natural balancing chemical buffers of the body are overcome and the blood acidity falls significantly, cardiac dysrhythmias can be produced and sudden death can occur. Postmortem analysis of the blood for β-hydroxybutyrate (BHB) is now readily available and should always be performed in all custodial deaths.

Given the speed with which an individual under the influence of alcohol can die from either the aspiration of vomit or from postural asphyxia it is very doubtful if a police station cell is the correct environment for their recovery from intoxication.

Illustrative Case *A homeless male was arrested by police for the theft of alcohol. He was unkempt and smelt of intoxicating liquor. He was slurring his speech and had an unsteady gait. The custody officer authorized his detention and on the risk assessment it was noted that the detainee said he drank alcohol every day. The detainee was placed in a cell, and as he was currently intoxicated with alcohol, he was checked and roused every half hour for four hours to ensure that his condition was improving. He was then left for a period of undisturbed sleep, though was observed hourly. Unfortunately there was a change of shift in the police station and the fact that the detainee was most likely alcohol dependent was not communicated to the incoming shift team. The detainee was found dead in the morning some 16 hours after his arrest. CCTV footage confirmed that he had seizure in the night prior to his death.*

Drugs

Drug use is now so ubiquitous in western society that any examination of a detainee by a HCP must include a very careful evaluation of drug use whether in the past or recently. The skill of the HCP will undoubtedly be stretched to the full in the evaluation of the history given and this is discussed fully in Chap. 12; much may depend on the failure to continue prescribed medication as on the failure to identify a detainee who is misusing substances who then suffers from withdrawal whilst in custody.

In terms of deaths in custody all drug use, whether social, misuse or therapeutic, is relevant [1–4, 13, 19] and the possibility that a detainee may have used just one drug or a combination of drugs with or without alcohol prior to death must be positively excluded. A full drug screen on blood and, if available, urine is imperative. Some laboratories will also examine samples of bile and/or liver to detect evidence of previous drug abuse. At postmortem the contents of the whole bowel must be examined to determine if packets or 'wraps' of drugs have been ingested in order to prevent detection during arrest 'body swallowers' or 'body packers'.

The management of acute drug intoxication is a matter of clinical judgment but with adequate medical care it is unlikely that, except in exceptional circumstances, drug intoxication alone will to lead to sudden death in custody.

Deliberate Injuries

Baton Blows

Blows from a baton are usually easily identified in that forceful blows produce the classic "tram line" type injuries on the skin. "Tram line" injuries are typical of a blow from a linear blunt object, the areas of the skin that are most traumatized are not those at the middle of the site of contact where the skin is most evenly compressed but rather at the margins on the contact site where the stretching and distortion of the skin, and hence the damage to the underlying tissues including the blood vessels, is most pronounced. A linear object will, almost by definition, have two such margins which run parallel and a blow from such an object results in two, linear, parallel bruises hence the terminology "tram line".

Blows from a baton may also result in deeper bruising, nerve damage and fractured bones. The deeper injuries tend to reflect the use of greater force but it is not possible to correlate with any degree of certainty the amount of force needed to cause a particular injury in any one individual.

It is essential for both the HCP who examines a living victim of a blow to the head from a baton (or from any other cause) and the pathologist who performs a post mortem examination to remember that significant cerebral trauma can have been caused even in the absence of obvious external trauma or skull fractures. It would be a matter of prudence to assess with great care anyone who has received, or complains of receiving, a head injury from a baton, or from any other cause, and to consider carefully if referral to hospital for a full neurological assessment would be advisable (see Chap. 9).

Neck Holds

Pressure on and around the neck is well known to be a potentially lethal action [13]. Death can be caused following compression of the neck by any one of four mechanisms or by a combination of two or more of them.

- Airway obstruction by direct compression of the larynx or trachea or by the pressure on the neck raising the larynx upwards and causing the superior aspect of the pharynx to be occluded by the base of the tongue. This can be achieved by pressure of a forearm across the front of the neck, sometimes called the "Choke Hold".
- Occlusion of the veins in the neck. The low pressure in the venous system and the thin yielding nature of the vein walls makes venous occlusion more easily achievable than arterial occlusion; however, the large reserve capacity of the venous system makes it unlikely that rapid death would result even if complete occlusion was achieved, unless some other factor supervened.
- Compression or occlusion of the carotid arteries. This is harder to achieve than venous occlusion due to the higher pressure in the arterial system and the thickness of the arterial walls; however, the effects of occlusion will become apparent much quicker. Saukko and Knight [13] record that occlusion of the carotid circulation for a period of 4 min or more may result in brain damage and Reay et al. [20] demonstrated significant changes in blood flow in the face of five individuals who were subjected to compression of the carotid arteries by the application of a "sleeper hold" in experimental conditions. A sleeper hold is applied when the upper arm compresses one side of the neck and the forearm the other and the larynx rests in the "V" formed by the elbow.
- The fourth mechanism by which death can occur during pressure to the neck results from stimulation of the vagus nerve by direct pressure in its course down the neck or as a result of stimulation of the carotid sinus. Vagal stimulation results in bradycardia which may progress to asystole or, in some cases, immediate asystole.

Mercy et al. [21] reviewed 20 deaths where neck holds had been applied and concluded that in 19 of these cases the application of the neck hold was associated with the death. Conversely, Kowai [22] concluded that the use of the Choke Hold could take between 10 and 20 s to cause unconsciousness and therefore it was safe. Clearly they did not experience the vagal effects of this hold in their experiments. The research of Sauvagneau and Geberth based on videos of fatal autoerotic hangings [23, 24] confirms that unconsciousness is lost after approximately 10 s of neck pressure but that the pressure usually needs to be applied for between 2 and 6 min for death to ensue.

Neck holds are commonly used in many forms of wrestling or martial arts and in these situations they are seldom associated with fatalities possibly because of the ability of the person held to indicate their willingness to submit to a referee and so cause the hold to be released. No such authority is present during a restraint by police and perhaps this is why fatalities are recorded in this situation. In the United Kingdom, the use of neck holds by police during restraint is specifically prohibited and officers are warned during their training of the potentially fatal effects of applying any pressure to the neck. In the USA, however, neck holds are an approved method of restraint.

The pathological examination of deaths associated with compression of the neck requires a detailed and careful dissection of the neck structures [25]. The finding of injuries to the muscular, cartilaginous, vascular, or neural components of the neck must, however, be interpreted in the light of the events of the restraint, the actions of the restrainers and the subsequent resuscitation (if any). Pressure on the neck to maintain an airway following cardiac or respiratory arrest may result in bruising which could be confused with pressure prior to, or indeed causing, that arrest. Therapeutic insertion of cannulae during active resuscitation by paramedics or in the hospital very commonly leads to quite marked hemorrhage into the neck which, while it is unlikely to be confused with bruising caused by a neck hold, may mask any bruising that was present.

Pressure on the neck is not, of course, the only mechanism whereby an individual may suffer anoxia or asphyxiation. Any action that occludes, partially or completely, the mouth and/or the nose will result in difficulty in breathing and may result in asphyxiation.

Restraint Asphyxia (See Chap. 7)

The area of restraint that has always caused most concern relates to asphyxiation during the act of restraint. It has been known in forensic circles for many years that individuals may asphyxiate if their ability to breathe is reduced by the position in which they are placed or into which they fall [26]. This type of asphyxiation is commonly associated with alcohol or drug intoxication or, rarely, with neurological diseases which prevent the individual extracting themselves from a position that either occludes, partially or completely, their mouth and nose or which limits the freedom of movement of the chest wall. Death resulting from these events has been described as Postural Asphyxia to indicate that it was the posture of the individual that resulted in the airway obstruction rather than the action of a third party.

In 1988, research by Reay et al. [27] was published which was initially thought to show that, in laboratory conditions, the placing of an individual in the hog-tie position significantly increased the time taken to return to resting blood oxygenation levels following moderate exercise. "Hog-tying" is a form of restraint where the detainee is placed face down and the hands are tied together and then to the feet. Reay concluded that positional restraint (hog-tying) had "measurable physiological effects". In 1992, Reay published a paper [28] which recorded six cases where, in his opinion, individuals had died as a result of "hog-tying" and being placed prone in police vehicles. This paper raised the possibility that asphyxiation was occurring to individuals when they could not move themselves to safer positions because of the type of restraint used by the police. The concept of "restraint asphyxia", albeit in a specific set of circumstances, was born.

Since the description of deaths in the prone, hog-tied position, Reay's original concepts have been extended to account for many deaths of individuals simply under restraint but not in the hog-tied position. The term "restraint asphyxia" has been widened to account for these sudden and unexpected deaths during restraint. Considerable pathological and physiological controversy exists regarding the exact effects of the prone position and hog-tying in the normal effects upon respiration.

Further experiments by Chan et al. [29] have cast considerable doubt on Reay's thesis although other experiments by Roeggla et al. [30] appear to support the original theory. While the physiological controversy continues, it is clear to all those involved in the examination and investigation of these deaths that there is a small group of individuals who die suddenly and apparently without warning while being restrained.

Physiological research on simulated restraint revealed [31, 32] that restraint did produce reductions in the ventilatory capacity of the experimental subjects but that this did not impair cardiorespiratory function. In two of the eight healthy subjects, breath holding following even moderate exercise was found to induce hypoxia-related dysrhythmias and it was noted that arterial oxygen saturation fell rapidly even with short breath hold times, especially if lung volume was reduced during exhalation.

The problem that currently faces the forensic pathologist is the determination of the cause or causes of these deaths. This is made harder since there are seldom any of the usual asphyxial signs to assist and, even if those signs are present, it is difficult to assign weight or significance to them since similar changes can be caused simply by resuscitation [33].

The major features of asphyxiation are cyanosis, congestion and petechial hemorrhages [13]. These features are seen to a greater or lesser extent in many, but not all, cases of asphyxiation. They often are completely absent in many plastic bag asphyxiations and in hanging, they have variable presence in manual strangulation and they are most commonly seen in ligature strangulation. But their most florid appearance are in deaths associated with postural asphyxia or crush asphyxia cases where death has occurred slowly and where it is associated with some form of pressure or force reducing the ability of the individual to maintain adequate respiratory movement, either from outside the body or from the abdominal contents splinting the diaphragm.

It is of interest then that these features, if present at all in these cases, are, at most, scanty and do not reflect their appearance in other cases of crush asphyxia suggesting that different mechanisms are the cause of death in these two sets of circumstance.

The individuals who die during restraint are not infrequently under the influence of drugs (particularly cocaine) or alcohol, they may be suffering from some underlying natural disease (particularly of the cardiovascular system) or they may have suffered some trauma. These "additional" factors are sometimes seized upon by pathologists and courts to "explain" the death, sometimes even in the face of expert opinion that excludes the additional factor from playing a major part in the death [34].

It would seem that there is a sub-group of the population who are either permanently or at times and for whatever reason susceptible to the effects of restraint whether those effects be mediated entirely or indeed partially through decreased respiratory effort or some other factor.

It should be noted that an individual who is suffering from early, or indeed late, asphyxiation may well struggle more and more in an attempt to breathe and, during a restraint, this increased level of struggling may be perceived by police officers as an renewed attempt to escape resulting in further restriction of movement and subsequent exacerbation of the asphyxial process. Officers need to be taught that once restrained these further episodes of struggling may signify imminent asphyxiation and not continued attempts to escape—that they may represent a struggle to survive and that the police must be aware of this and respond with that in mind.

Homicide

There have been a number of cases where individuals have been murdered in the cell by another inmate. These deaths are most commonly associated with blunt trauma but strangulation, stabbing and other methods may be employed if suitable weapons are available. It is also evident that individuals have been deliberately assaulted and killed by police officers during arrest and detention.

The HCP should always be aware of the possibility that excessive force may have been applied by the police or that deliberately homicidal injuries may have been inflicted. If injuries are present on any individual in their care these injuries must be carefully documented and, if they are beyond that which the HCP considers reasonable in the circumstances, their concerns should be expressed immediately to a senior officer, a legal representative of the detainee, and through an official complaints procedure. The HCP also has the duty to ensure that no further harm comes to that person.

Self-Inflicted Injuries

Suicidal deaths in custody are a cause for continuing public concern. The methods used are variable but reflect the materials available to the individual at that time.

Hanging

In order to effect a hanging suicide the individual must have two things; an object that can be made into a noose and a point to fix it to. In addition they must be able to place their body so that at least some of their own body weight can be used to apply pressure to their neck via the noose.

The materials and objects that can be made into a noose are legion and vary from the obvious (ties, belts, shoelaces, etc.) to the unusual (underwear, shirts, etc.). In order to attempt to reduce the possibility of hanging suicides, many cells in police stations have been redesigned and attachment points for the noose (pipes, bars, etc.) have been removed or covered. The lack of these obvious points did not, however, previously deter some individuals who placed the bed “on end” and used the upper end as the fixing point. Installation of fixed beds or benching should preclude the use of that method in future. It must be remembered that hanging can still be achieved, although is clearly more difficult, from a low suspension point and any protrusion from a wall or fitment in a cell can potentially be used as the upper attachment for the noose.

In addition to removal of the fixing points, attempts have been made to remove the items that have been used as nooses in the past and belts, shoelaces, etc. are sometimes taken from prisoners. Paper clothing has been used although this has not been entirely successful as it entails removing all of the individual's clothing which is clearly impractical in many cases and may raise problems with human rights, and any paper clothing strong enough to withstand any degree of wear would also be strong enough to act as a noose.

The key to preventing hanging suicides lies in the careful evaluation of all individuals who are to be detained (see Chap. 9) and in the design of the cells in which they are held to preclude any possible point for the attachment of a noose.

Given the speed with which hanging can be effected [23, 24], it is most unlikely that anything other than a permanent watch over the suicidal detainee would provide a foolproof method to prevent hanging in a cell. A cycle of 15 min checks will allow more than ample time for an individual to hang themselves and cannot be considered to be adequate protection against this type of suicide.

Ligature Strangulation

As the possibility of suspension is reduced by the changes in the design of the cells, the possibility of other forms of self-asphyxiation are likely to increase. Self-strangulation by ligature is considered to be possible but difficult [13]; since the pressure has to be applied to the neck in these cases by the conscious muscular effort of the hands and arms, it follows that when consciousness is lost and the muscular tone lessens the pressure on the ligature will decrease, the airway obstruction and/or the vascular occlusion will cease and death will generally be averted. If, however, the ligature is knotted or if the material is "non-slip" and looped around itself then it is possible for the individual to apply the pressure to the neck and for that pressure to be maintained even after consciousness is lost and, as a result, death may follow.

As with hanging, the key to preventing these deaths lies in careful evaluation and, if necessary, the removal of items of clothing and observation.

Incised Injuries

All detainees should be carefully searched before incarceration and any sharp objects, or objects that could be sharpened, must be removed. The extent of the search will probably depend on the mental state of the individual and the possibility of an intimate search to exclude weapons concealed in the vagina or rectum should be considered in those individuals considered most at risk. Death from deep incised wounds to the neck or arms can occur very quickly, even if found before death has occurred the effects of profound blood loss may make death inevitable despite attempts at resuscitation.

Drugs

When considering the possibility of suicide using drugs while in police custody the two key factors are, once again, evaluation and searching. Careful searching (possibly including intimate searches in some cases) will prevent the ingestion of drugs by an individual after they have been placed in the cell. The HCP must always be aware of the possibility that excessive quantities of a drug, or drugs, were taken prior to arrest and detention which may exert their effect when the individual is in the cell.

Acute Behavioral Disturbance

Acute behavioural disturbance (ABD) is a term covering a wide range of presenting conditions. In police custody probably the commonest causes are substance misuse (especially stimulant use) and psychiatric disorders. However the differential diagnosis includes a number of conditions:

- psychiatric disorders
- substance misuse (stimulants—cocaine, amphetamine, methamphetamine; synthetic cannabinoids)
- serotonin syndrome
- anticholinergic syndrome
- sepsis
- head injury
- hypoglycaemia
- seizures
- hypoxia
- thyroid storm
- akathisia

ABD and excited delirium or excited delirium syndrome (ExDS), are terms often used interchangeably with only about one third of cases of ABD presenting as ExDS, the most severe end of the spectrum of disturbance [35]. The definition of ExDS has been defined as ‘a state of extreme mental and physiological excitement, characterized by extreme agitation, hyperthermia, hostility, exceptional strength, and endurance without apparent fatigue’ [36]. It should be noted that Luther V Bell, an American physician, first described ExDS in 1849 [37]. There has been controversy over this diagnosis which is currently not recognized in the Diagnostic Statistical Manual (DSM-V) and the International Classification of Disease (ICD-9). However the diagnosis is recognized as a distinct entity by emergency physicians and medical examiners/pathologists [38] in the USA.

Where ABD/ExDS is suspected individuals should be taken directly to the local hospital emergency department as this is a time critical medical emergency. However should a detainee be taken into police custody the duty HCP needs to recognize the features of ABD/EXDS (Table 13.3) and advise that immediate hospitalization is

Table 13.3 Clinical Features of ExDS

Tactile hyperthermia
Does not fatigue
Naked/inappropriately clothed
Rapid breathing
Sweating profusely
"Superhuman" strength
Increased pain threshold/tolerance
Constant/near constant activity
Glass attraction-destruction
Non-responsive to others presence
Violent behaviour

required for urgent treatment for the agitation, hyperthermia and acidosis. Whilst awaiting transfer to hospital preliminary steps can be made with regard to diagnosis and causation but any delay to definitive treatment should be avoided. Preliminary steps may include de-escalation and pre-tranquilization.

Guidelines on the management of suspected ABD in police custody are available for these situations [39].

There appears to be significant morbidity and mortality associated with these conditions but the high mortality rate may be due to definition inconsistency and reporting bias [40]. If a death in police custody is suspected to be a result of ABD/ExDS it is essential that a forensic pathologist is involved to conduct the post-mortem and interpret the relevant toxicological analyses. In a cocaine-related death, for example, the plasma levels of cocaine may only be modestly elevated, the heart will invariably be abnormal (enlarged) with microscopic evidence of myocardial remodeling, secondary to chronic cocaine use [41]. Relatives may wish to have an independent pathologist present as is standard practice in the United Kingdom.

Illustrative Case *A young male had taken amphetamines and then started exhibiting bizarre behavior, agitation, paranoia, hallucinations, aggression, overheating, and extreme strength. He left his house in only his underwear. His parents called the police. He was restrained with leg restraints and handcuffs, a spit hood was applied, and he was taken to a police station. During a period of over an hour he remained restrained by six officers. Eventually a forensic physician suggested that he needed to go to hospital as he had taken drugs. An ambulance was called and the male was taken to a police van where he was restrained by three police officers in a caged area. He stopped breathing, and although transported directly to hospital, he died later that day.*

Role of the HCP Following a Death in Custody

If a death occurs in the police custody venue then a HCP may be called to pronounce life extinct. If that HCP has been involved in the earlier care of the deceased then he/she should advise the police that another HCP should be asked to confirm that life is extinct. This avoids any later suggestion of collusion or cover-up.

Table 13.4 Verification of life extinct [43]

Absence of carotid pulse over 1 min
Absence of heart sounds over 1 min
Absence of respiratory movements and breath sounds over 1 min
Fixed, dilated pupils
No corneal reflexes
No motor response to painful central stimulus e.g. supra-orbital pressure, trapezius squeeze

The HCP who attends to confirm life extinct (Table 13.4) should make very careful records of the scene and condition of the body [42]. However the police will guide the HCP as to the exact extent of the examination till a suitably qualified forensic pathologist arrives at the scene.

Advice should be sought urgently from the forensic pathologist as to whether the body temperature should be obtained; this could help identify deaths from ABD/ExDS and may assist in the determination of the time of death (often a critical factor when the IOPC come to investigate the deaths and questions are asked about the frequency of visits by custody staff). The HCP should ensure that the Scene of Crime Officer/Crime Scene Investigator takes the ambient temperature.

Whenever a death in custody occurs the actions of any HCPs who have been involved in the care of the detainee may be considered during the investigation. Therefore, HCPs should appraise their Clinical Lead/Line Manager/Medical Director of the incident in order to receive advice and support.

The IOPC, Coroner (or equivalent) and internal investigations branch of the police force involved will all be carrying out investigations. There is also a clinical governance requirement for the clinical forensic medical service to review the assessment and treatment of any detainee who dies in police custody to ensure that any lessons are learnt as soon as possible.

Conclusions

The problem for the police remains that while approaching and restraining an individual they cannot know the background or the medical history nor can they have any idea of the particular (or peculiar) physiological responses of that individual. The statistics may suggest that the techniques that have been designed and taught for restraint, and the care of the individual after restraint, appear to be leading to safer restraint by police (and prison officers) of the most vulnerable sections of the community. Unfortunately restraint-related deaths caused by untrained civilian "security" guards appear to be becoming more common—and almost impossible to trace statistically.

The considerable interest by Government and by the public in all forms of deaths in custody over many years now has resulted in the increased availability of reliable and up-to-date statistics. The increased attention to these deaths has also resulted in the necessity for the much more detailed "ECHR Article 2 compliant" inquests however the inordinate length of time taken by the legal system, both Coronial and Criminal, to complete their consideration of these deaths frustrates much of the immediate understanding of the mechanisms of each individual death and undoubtedly increases the distress of many families, and also of the police officers involved in such a death.

Key Points
Deaths in police custody are particularly important for the following reasons:

- there is always the suspicion that the death was due to an act of commission or omission by the police;
- they are frequently a cause of public concern and create media interest;
- they will always be investigated by independent police officers and the IOPC (or equivalent);
- they are usually subject to a Coroner's inquest (or equivalent) and occasionally are the subject of a public inquiry.

Self-Assessment Exercises

1. What are the main causes of deaths in police custody?
2. What is the definition of Excited Delirium (ExDS)? What are the clinical features of ExDS?
3. What examination is required to verify life extinct?

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Traffic Medicine

14

Ian F. Wall and Margaret M. Stark

Learning Objectives

To describe the medical conditions that significantly affect fitness to drive.

To recall the legal limits for alcohol in blood, breath and urine.

To be able to demonstrate the procedure for taking samples from suspected drink and drug drivers.

To explain the effects of common illicit drugs on driving.

To discuss the limitations of Field Impairment Tests.

Introduction

The United Nations established a road safety collaboration in 2011 with the aim of saving lives: the 'Decade of Action for Road Safety 2011–2020'. However the number of road traffic deaths is still rising and the most recently reported figure was 1.35 million in 2016, but the rate of death relative to the size of the world's population remains constant [1]. There are number of key risk factors that are essential to prevent road traffic deaths; these include reducing speed, drink driving, use of motorcycle helmets, seat belts and child restraints. Currently, 123 countries, representing nearly six billion people, have laws that meet best practice for at least one of the five key behavioral risk factors [1].

The estimated road traffic death rate per 100,000 of the population varies. In 2016 in Australia it was 5.6 per 100,000 compared to United States 12.4 and United Kingdom 3.1 [1]. However in the UK there has been little reduction in road deaths

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since 2010 and number of seriously injured casualties have increased [2]. Driving a motor vehicle is a complex task requiring a reasonable level of physical fitness, accurate perception, and appropriate judgment. All these factors can be affected by drugs and alcohol, greatly increasing the risk of accidents. Many medical conditions (and their treatments) may impair fitness to drive and will first be considered.

Medical Aspects of Fitness to Drive

Licensing requirements depend on the type of vehicle driven, with more stringent requirements for commercial purposes and multi-axle vehicles.

The legal basis of fitness to drive in the UK lies in the following legislation:

- The European Third Directive on driving licenses (2006/126/EC) effective in the UK in January 2013
- The Road Traffic Act 1988
- The Motor Vehicles (Driving Licences) Regulations 1999 (as amended).

According to Section 92 of the Road Traffic Act 1988:

- A relevant disability is any condition which is either prescribed in regulations or any other disability where driving is likely to be a source of danger to the public. A driver who is suffering from a relevant disability must not be licensed, but there are some prescribed disabilities where licensing is permitted provided certain conditions are met.
- Prospective disabilities are any medical conditions that, because of their progressive or intermittent nature, may develop into relevant disabilities in time e.g. Parkinson's disease and early dementia. A driver with a prospective disability may be granted a driving license for up to 5 years, after which renewal requires further medical review.

In many jurisdictions, including Canada and the United Kingdom, it is the motorist's responsibility to inform the licensing authority of any relevant medical conditions. Similar requirements generally apply in the United States, except that several states (California, Delaware, Nevada, New Jersey and Utah) actually require physicians to report patients with seizures (and other conditions that may alter levels of consciousness) to the department of motor vehicles [3]. Similarly, in two states in Australia (South Australia and the Northern Territory), reporting of patients with seizures (or indeed if the practitioner believes that the person is physically or mentally unfit to be licensed) is compulsory and there are penalties for doctors not reporting [4]. Drivers themselves have a legal responsibility to inform the licensing authority of any injury or medical condition that affects their driving ability, and physicians should take great pains to explain this obligation. Occasionally, especially when dealing with patients suffering from dementia, ethical responsibilities may require doctors to breach confidentiality and notify patients against their will or without their knowledge [5]; this situation will be considered later.

Requirements vary in different countries and in different jurisdictions within the same country. When in doubt about the appropriate course of action, physicians or other healthcare professionals should consult the appropriate guidelines. In the United Kingdom, the Driver and Vehicle Licensing Agency (DVLA) has made available a detailed guide for assessing fitness to drive for medical professionals [6]. In Australia, the Austroads Guidelines for Assessing Fitness to Drive provides information [4] and similarly in New Zealand, the NZ Transport Agency [7]. In the European Union, where EC directives have developed basic standards but allow different countries to impose more stringent requirements, there is still considerable variation from country to country. The situation is even more complicated in the United States, where each state sets its own rules, and where Federal regulations for commercial vehicles apply as well. Often, much of the required regulatory information can be acquired via the internet, or from organizations and foundations representing patients who have the particular disease in question [8].

It should be assumed that all adults drive; drivers with disabilities should be given special consideration and may require modification of their vehicle or have certain personal restrictions applied.

Cardiovascular Diseases

A number of studies have demonstrated that natural deaths at the wheel are fairly uncommon and that the risk for other persons is not significant [9, 10]. Even so, requirements for commercial drivers are generally much more rigid than for individuals, and in the United States, the Federal Highway Administration prohibits drivers with angina or recent infarction from driving. The length of prohibition varies from state to state. Restrictions for noncommercial car driving, after first acute myocardial infarction, are 4 weeks in United Kingdom (though only 1 week if treated by percutaneous coronary intervention) but only 2 weeks in Australia (2 days if treated by percutaneous coronary intervention). In the United States, they are entirely at the discretion of the individual physician. In general, myocardial ischemia itself is not considered an absolute driving disqualification, provided treadmill stress testing demonstrates that moderate reserves are present [11]. Similarly, individuals with controlled hypertension are usually considered fit to drive, although physicians, no matter what country they are in, must give serious thought to just what sort of medication is used to control hypertension; clonidine, methyldopa, reserpine, and prazosin can produce somnolence and/or impair reflex responses.

Patients with dysrhythmias, treated with medication or with the implantation of a defibrillator/pacemaker, present a special set of problems [12]. The tendency in the United States has been to treat such individuals as if they were epileptics, i.e., individuals with the potential to lose consciousness at the wheel. Even then, the distinction is not absolute, as some individuals with implanted devices are at much higher risk for syncope than others [13], and the ultimate decision remains that of the attending physician.

Most states set minimum requirements for arrhythmia-free periods. Until fairly recently, that period was 6 months in a majority of jurisdictions but is increasingly being shortened to 3 months in many locations. In the UK, patients with implantable cardioverter defibrillators are permanently barred from holding a group 2 license, but may hold a group 1 license providing the device has been implanted for 6 months and has not administered therapy (shock and/or symptomatic antitachycardia pacing) [6].

Epilepsy

Epilepsy is the commonest cause of collapse at the wheel, accounting for approximately 30% of such incidents. In the United Kingdom, epilepsy is a Relevant Disability for purposes of the Traffic Act 1988 (Prescribed Disabilities being severe mental impairment, sudden attacks of disabling giddiness, and inability to meet eyesight requirements) and car driving is not allowed for at least 1 year after a seizure. Here too, restrictions vary from country to country. All 50 of the United States restrict the licenses of epileptics if their seizures are not well controlled by medication. Most states require a 6-month seizure-free period and a physician's statement confirming that the individual's seizures have, in fact, been controlled and that the individual in question poses no risk to public safety. The letter from the physician is then reviewed by a medical advisory board, which may or may not issue a license. In the United States, even if the patient, at some later date, does have a seizure and cause an accident, the physician's act of writing to the board protects him or her from liability under American law, provided the letter was written in good faith.

Withdrawal of antiepileptic medication is associated with a risk of seizure recurrence. One study showed that 41% of patients who stopped treatment slowly developed a recurrence of seizures within 2 years compared with only 22% of patients who continued treatment [14]. Austroads [4] and the DVLA [6] give detailed guidance on driving after physician approved medication reduction. The legal consequences of discontinuing medication, without a physician's order, can be quite devastating. Patients who stop taking antiseizure medication of their own volition and then cause an accident may face future civil liability and possibly even criminal charges if they cause physical injury [15]. Of course, rules vary from country to country, but, in general, a seizure patient who does not inform the appropriate regulatory agency may face dire consequences (including even the legitimate refusal of the insurance carrier to pay for damages).

Diabetes

Diabetes-related hypoglycemia may lead to confusion or loss of consciousness, or from complications of the disease itself, e.g., retinopathy causing visual problems or peripheral vascular disease causing limb disabilities. In the UK, all diabetics must meet the criteria to drive and must notify the DVLA. Group 2 license (bus and lorry) requirements are strict, although insulin treated drivers are allowed to drive subject to regular blood glucose testing even on days when not driving, 2 hourly monitoring when driving and an annual review by an independent specialist in diabetes [6]. Similar strict licensing requirements also apply in Australia [4].

In the United States, the situation varies from state to state and states identify drivers with diabetes in a number of ways. In at least 23 states [16] drivers are asked directly if they have diabetes whereas in other states drivers are asked some variation of a question about whether they have a condition that is likely to cause altered perception or loss of consciousness while driving. In some states, physicians are specifically required to notify authorities of the patient's diabetic conditions. As with seizure patients, failure to notify may expose the patient to both civil and criminal liability. Studies have shown that the single most significant factor for drivers with diabetes appears to be a recent history of severe hypoglycaemia, regardless of the type of diabetes or the treatment used [17].

Vision and Eye Disorders

The two most important aspects of vision in relation to driving are visual acuity and visual fields. Visual acuity may simply be defined as the best obtainable vision with or without spectacles or contact lenses. Most countries require a binocular visual acuity greater than 6/12 for licensing purposes. In the United Kingdom, the eyesight requirements are in good daylight, ability to read the registration mark fixed to a vehicle registered under current standards at a distance of 20 m with letters and numbers 79 mm high by 50 mm wide on a car registered since 1 September 2001 or at a distance of 20.5 m with letters and numbers 79 mm high by 57 mm wide on a car registered before 1 September 2001. The minimum field of vision for safe driving is generally regarded as at least 120° on the horizontal when measured with a Goldman III4e target or its equivalent [6].

Ethical Considerations

While it is generally a patient's responsibility to inform the licensing authority of any injury or medical condition that affects their driving, occasionally ethical responsibilities may require a doctor to inform the licensing authorities of a particular problem. If a patient has a medical condition that renders them unfit to drive, the doctor should make sure the patient understands that the condition may impair their ability to drive. If the patient is incapable of understanding this advice, e.g., due to dementia, the doctor should inform the licensing authority immediately [18].

If patients continue to drive when they are not fit to do so, the doctor should make every reasonable effort to persuade them to stop. The doctor may decide to discuss concerns with the patient's relatives, friends and carers as long as the patient agrees.

If this still does not persuade the patient to stop driving and the doctor is of the opinion that the patient's refusal to stop driving leaves others exposed to risk of death or serious harm, the doctor should disclose relevant medical information immediately, in confidence, to the medical adviser of the licensing authority. Before disclosing this information, the doctor should inform the patient of the decision to do so, and once the licensing authority has been informed, the doctor should also write to the patient to confirm that disclosure has been made and make a note on the patient's record [18].

Alcohol and Driving

Globally it is estimated that 5–35% of all road deaths are reported as alcohol related [1]. In the UK a *drink-drive accident* is a reported incident on a public road in which someone is killed or injured, where at least one of the motor vehicle drivers or riders involved met one of the following criteria:

- failed a roadside breath test by registering above 35 µg of alcohol per 100 mL of breath (in England and Wales) or 22 µg (in Scotland)
- refused to give a breath test specimen when requested by the police (other than when incapable of doing so for medical reasons)
- died, within 12 h of the accident, and was subsequently found to have more than 80 mg of alcohol per 100 mL of blood (in England and Wales) or 50 mg (in Scotland) [19].

The provisional central estimate of the number of deaths in accidents with at least one driver over the alcohol limit for 2017 is 290 with the central estimate of the number of drink-drive casualties of all severities in 2017 is 8660, a decrease of 4% on 2016 [19].

Metabolism of Alcohol [20]

Alcohol is absorbed through the stomach and duodenum. Absorption is dependent on many factors, including age, sex [21], weight and adiposity of the individual, duration of drinking, nature of the drink, and presence of food in the stomach. Alcohol dehydrogenase in the gastric mucosa may contribute substantially to alcohol metabolism (gastric first-pass metabolism), but this effect is generally only evident with low doses and after eating. Studies of alcohol dehydrogenase activity in gastric biopsies of women suggest a significant decrease in activity in women compared with men, which could explain why women have higher peak blood alcohol levels and are more susceptible to liver damage after consumption of smaller quantities of alcohol when compared with men [22]. Further details of alcohol metabolism are given in Chap. 8. Once absorbed, alcohol is eliminated at a fairly constant rate, with 90% being metabolized in the liver and the remainder excreted unchanged in urine, breath, and sweat. The rate of elimination in moderate drinkers may vary between 10 and 20 mg/100 mL blood/h, with a mean of 15 mg/100 mL blood/h. Individuals dependent on alcohol, undergoing detoxification, have elimination rates of 19 mg/100 mL blood/h or even higher [23]. This increased rate of alcohol burn off is thought to be a consequence of increased activity of hepatic microsomal enzymes (P450IIE).

Effects of Alcohol on Performance

Alcohol affects mood and behavior, causing euphoria (which is particularly significant in risk taking), but it also produces central nervous system depression. Even at low doses, there is clear evidence that alcohol impairs performance, especially as the faculties that are most sensitive to alcohol are those most important to driving, namely complex perceptual mechanisms and states of divided attention. In a review of over 200 papers [24], a variety of behavioral aspects were examined including reaction time, tracking, concentrated attention, divided attention, information processing, visual function, perception, psychomotor performance, and driver performance. Most of the studies showed impairment at 70 mg/100 mL blood, but approximately 20% showed impairment at concentrations between 10 and 40 mg/100 mL blood.

The definitive study on the relationship between risk of accident and blood alcohol concentration (BAC) was performed in the 1960s in Grand Rapids, Michigan by Borkenstein and Dale [25]; data were collected on 5895 drivers involved in accidents and on 7590 drivers not involved. Comparison of the two groups disclosed that an accident was statistically more likely at blood alcohol levels greater than 80 mg/100 mL blood, with accidents occurring more frequently as follows:

Blood alcohol (mg/100 mL)	Accident occurrence
50–100	1.5 times as frequently
100–150	4 times as frequently
Over 150	18 times as frequently

Further analysis of the data by Allsop [26] quantified the risks for different ages and different drinking habits. On average, the risk doubles at 80 mg/100 mL, increasing sharply to a 10-times risk multiplier at 150 mg/100 mL and a 20-times risk multiplier at 200 mg/100 mL blood. For inexperienced drivers and infrequent drinkers, the sharp increase occurs at much lower levels, whereas for the more experienced drinking driver it may not occur until 100 mg/100 mL (Fig. 14.1).

This research contributed to some countries lowering the allowable BAC for legal driving and in Australia, Canada, the United States and more recently in Scotland. Different concentrations and rules are also applied for younger and/or inexperienced drivers in some countries. As an example, most states in Australia require a zero alcohol level for probationary drivers during their first 3 years of licensing. Further evidence of the relationship between crash risk and blood alcohol levels has been shown by Compton et al. [27] who studied drivers in California and

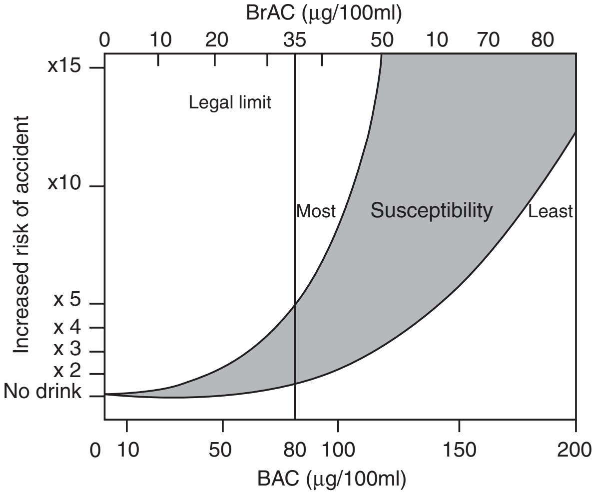

Fig. 14.1 Risk of road traffic accidents related to level of alcohol in the blood and breath. *BAC* blood alcohol concentration, *BrAC* breath alcohol concentration. Permission by Greenwich Medical Media

Florida. This research, surveying a total of 14,985 drivers, produced results that were in agreement with previous studies in showing increasing relative risk as blood alcohol levels increase, with an accelerated rise at levels in excess of 100 mg/100 mL blood. However, after adjustments for missing data (hit-and-run drivers, refusals, etc.), the result was an even more dramatic rise in risk, with the relative risk of crash involvement being significantly elevated at blood alcohol levels of 40 mg/100 mL. More recent research now has concluded that there is strong evidence that someone's ability to drive is affected if they have any alcohol in their blood with drivers with a BAC of between 20 and 50 mg/100 mL having at least three times greater risk of dying in a vehicle crash [28].

Road Traffic Legislation

In the United Kingdom, this research led to the introduction of the Road Safety Act 1967, which set a legal driving limit of 80 mg/100 mL of blood (or 35 μg/100 mL of breath or 107 mg/100 mL of urine). This law also allows mandatory roadside screening tests and requires the provision of blood or urine tests at police stations. The Transport Act 1981 provided that quantitative breath tests, performed with approved devices, could be used as the sole evidence of drunk driving. Although the level for drivers in England and Wales is currently set at 80 mg/100 mL of blood, in practice drivers are not usually prosecuted at blood levels below 87 mg/100 mL of blood because, during the analysis, a series of results by gas chromatography (which must fall within three standard deviations (or 6%) of each other) is averaged, and then 6% (or 6 mg below 100 g/100 mL) is deducted from the result, which is then reported as not less than × mg/100 mL of blood. The North report [29] (see later) recommended that in the United Kingdom, laboratories should apply a 3% allowance to the analysis of blood and urine specimens.

The legal limits in Scotland were reduced on 5 December 2014 to 50 mg/100 mL of blood (or 22 μg/100 mL breath or 67 mg/100 mL of urine). Recent research [30] has shown that this reduction was not associated with a reduction in road traffic accidents. One plausible explanation cited was that the legislative change was not suitably enforced—for example with random breath testing measures. However a study in the US evaluated the effects of lowering the BAC from 0.10 g/dL to 0.08 g/dL across all 50 states and the District of Columbia and provided strong evidence of the relationship between lowering the BAC limit for driving and the general deterrent effect on impaired driving fatal crash rates [31].

Lower legal limits in Northern Ireland were passed in April 2016 at 50 mg/100 mL of blood and 20 mg/100 mL for learner, novice or professional drivers to bring the levels in line with those in Ireland but have so far not been enacted.

In Australia, the legal limit is set at 50 mg/100 mL for fully licensed drivers for all states but lower levels are in place for other categories of drivers and vary by state e.g. a zero limit for drivers on a learner permit or probationary license, bus and taxi drivers and drivers of trucks over 15 tons.

In the United States, many states have enacted "zero tolerance" laws, and the detection of any alcohol in an individual younger than age 21 is grounds for license revocation.

Equivalent Limits in Other Body Fluids

Statutes have been used to establish BAC equivalents in other tissues and breath. Not infrequently, alcohol concentrations will be measured in accident victims taken for treatment at trauma centers. However, there are two very important differences between alcohol measurements made in hospitals and those made in forensic laboratories; first, in hospitals, standard international units (SI) are the norm, the mole is the unit of mass, the liter is the unit of volume, and alcohol concentrations are reported in mmol/L. In forensic laboratories, results are expressed as gram/deciliter or liter, or even milligrams per milliliter, and measurements are made in whole blood, not serum or plasma. Because 1 mL of whole blood weighs, on average, 1.055 g, a BAC of 100 mg/dL is actually the same as 95 mg/100 g or 21.7 mmol/L [23].

There is another, even more important, difference between serum/plasma and whole blood. The former contains 91.8% water, while the latter contains only 80.1% water. Because alcohol has a very large volume of distribution, this difference in water content means that alcohol concentrations measured in serum/plasma will be higher than concentrations measured in whole blood by approximately 14%. In practice, if plasma alcohol concentrations are to be introduced as evidence, they should be related back to whole blood concentrations using an even higher ratio (1.22:1), which corresponds to the mean value, ±2 standard deviations. As mentioned earlier, if whole blood is tested, drivers are not usually prosecuted at blood levels below 87 mg/100 mL of blood [23].

Table 14.1 Prescribed blood alcohol levels in various jurisdictions

Australia	50	France	50	Poland	20
Austria	50	Germany	50	Romania	0
Belgium	50	Greece	50	Russia	0
Bulgaria	50	Hungary	0	Slovakia	0
Canada	80	Italy	50	Sweden	20
Czech Republic	0	Lithuania	40	Spain	50
Denmark	50	Luxembourg	50	Turkey	0
Ireland	50	Netherlands	50	US	80
Finland	50	Norway	20		

Breath testing is equally problematic. The instruments used are calibrated to estimate the concentrations of alcohol in whole blood, not plasma or serum. To estimate the serum or plasma alcohol concentration from breath measurements, a plasma/breath ratio of 2600:1 must be used (because, as explained above, whole blood contains 14% less alcohol). In Europe, but not necessarily in the United States or Australia, two specimens of breath are taken for analysis, and the specimen with the lower proportion of alcohol should be used as evidence.

Bladder urine, because it contains alcohol (or other drugs) that may have accumulated over a long period, is generally not considered a suitable specimen for forensic testing, especially since the presence of alcohol in the urine only proves that alcohol is present in the body. Alcohol concentrations in bladder urine cannot be used to infer the blood levels reliably. Even so, U.K. legislation and most U.S. states still allow drivers the option of providing breath, blood, or urine specimens, but as of 1999, the State of California has dropped the option of providing urine samples, and other states are considering similar actions. Under the new California provisions, police can still request a urine test if a suspect's breath test is negative [32].

Other options are available in the case of alcohol-related fatalities. Comparison of alcohol concentrations in vitreous and blood can provide a good indication of whether concentrations were rising or falling at the time of death (alcohol is distributed mainly in water and the water content of vitreous is lower than that of blood). Urine obtained from the kidney pelvis can also be used, since its alcohol content can be precisely related to blood concentration [33].

Legal Limits in Other Jurisdictions

Table 14.1 shows alcohol limits for various countries but many countries have graduated penalties depending on the BAC.

Countermeasures

A number of measures are in place to discourage drivers from drinking, and they have had a considerable degree of success.

Lowering the Legal Limit

When the legal limit was reduced in Sweden from 50 to 20 mg, there was a fall in casualties [34]. It has been estimated that a similar reduction in the United Kingdom would save 50 lives, prevent 250 serious injuries, and eliminate another 1200 slight injuries each year. In 1998, a cost/benefit analysis suggested that this would save £75 million a year [35]. However, the UK Government decided not to implement this reduction. In 2010 the UK Government commissioned a report [29] by Sir Peter North QC to review current drink/drugs driving legislation. He again recommended the lowering of the legal limit to 50 mg but again the UK government decided not to implement this change. Other recommendations were made in his report for drink and drug driving and many of these will be mentioned later in this chapter.

Widening Police Breath Testing Powers

At present, in the United Kingdom, a police officer may stop any person driving a motor vehicle on the road, but that does not necessarily mean that the officer can administer a breath test. The number of breath tests continues to fall in the UK with only 325,887 breath tests carried out by police in 2017, the lowest number since the data collection began in 2002 [36].

In the United States, police officers can require a breath test only if there is reasonable cause to suspect that the person detained has alcohol in their body, has committed a moving traffic offense, or has been involved in an accident. However in Canada mandatory alcohol screening became law in 2018 giving police the authority to demand a breath test of any driver even in the absence of suspicion or cause.

In Finland, random breath testing along with a legal limit of 50 mg/100 mL of blood was introduced in 1977; highly visible check points are established, and typically, 8–12 policemen with breath alcohol screening devices are placed along the center of the road, the sites being chosen so that it is impossible for a driver to avoid being tested. All drivers are tested except those of emergency vehicles. The procedure takes only seconds to perform, the system receives general public support [37], and it has resulted in a marked reduction in the number of accidents and injuries.

In NSW, Australia, random breath testing started in 1982 and trauma from fatal crashes involving alcohol has dropped from about 40% of all fatalities to 15% in 2017 with police conducting about five million breath tests each year in NSW [38].

Ignition Interlocks for Repeat Drink-Drive Offenders

These devices prevent the car ignition from being started unless the concentration of breath alcohol blown into the device is below a predetermined level, often well below the legal limit. Thereafter, during the journey, the driver is required to undertake random rolling retests. A failure of these tests activates the vehicle's lights and horn. All states in the United States have some type of ignition interlock law and several states have made them mandatory or highly incentivized for all convicted drunk drivers, even first time offenders. The same applies in Australia with all States and territories having laws relating to interlock programs. From 1 October 2014 in Victoria, Australia, anyone who loses their license or learner permit due to a drink-driving offense is required to install an alcohol interlock in any vehicle they drive as a condition of relicensing [4]. Results in the United States have shown that repeat offenses occur rapidly once the restriction is removed [39]. However, in Alberta, where there is closer supervision of the program, supplemented by counseling, more long-term improvements have been experienced. Though they are currently not the subject of any legal penalty in the United Kingdom, interlock devices can be purchased on a private basis. The North report recommended that best practice on interlock devices should be rolled out throughout the transport industry in the United Kingdom [29].

High-Risk Offender Scheme

A special program in England, Wales, and Scotland was introduced in 1983, and the criteria widened in 1990 to cover drivers who were convicted of having a BAC in excess of 200 mg/100 mL blood, or refusing to provide an evidential specimen, or two offenses involving BACs in excess of 80 mg/100 mL blood within a 10-year period. This group accounts for about 30–40% of drunk driving offenders in Britain. To regain their licenses at the end of a period of disqualification, the drivers must undergo a medical examination (including blood tests to discover biochemical evidence of excessive alcohol consumption) to demonstrate with reasonable certainty that they are not alcohol abusers [6]. Similar statutes apply in the United States. In California, drivers found to have a BAC greater than 200 mg/100 mL, in addition to whatever other sanctions are imposed, are required to attend a 6-month educational program [32]. In the United States, penalties for drunk driving may be “enhanced” under special circumstances, such as a second conviction for drunk driving, or speeding at the time of arrest, or the presence of a child in the car, or the causation of property damage or injury.

Procedural Issues

While the procedures involved may seem very simple, numerous technical defenses have been raised in most countries around the world. Not surprisingly, many of these challenges are very similar, no matter the country in which they are offered. Challenges to the U.K. Road Traffic Act are illustrative of the problem.

Definitions

Section 5(1) of the Road Traffic Act 1988 (subsequently referred to as RTA) states that: if a person drives or attempts to drive a motor vehicle on a road or other public place, or is in charge of a motor vehicle on a road or other public place, after consuming so much alcohol that the proportion of it in his or her breath, blood, or urine exceeds the prescribed limit, he or she is guilty of an offense. Unfortunately, the word “drive” is not actually defined, but in fact, three points need to be proved: first, that the person is in the driving seat or has control of the steering; second, that the person charged must have something to do with the propulsion of the vehicle; and finally, that what the individual was doing must fall within the normal meaning of driving.

Attempting to drive has produced an abundance of case law, but it has been held that acts of mere preparation, e.g., checking the engine, finding keys, or opening the car door, do not amount to attempting to drive but steps on the way to what would have been driving, if not interrupted, may amount to an attempt, e.g., putting the key in the ignition. However, in a test case in the UK, when police found a man asleep in his van with the doors locked while over the legal limit, judges ruled by a majority decision that the laws that led to his conviction were “disproportionate” and “violated the presumption of innocence” to which he was entitled under Article 6(2) of the European Convention on Human Rights [40].

In Section 185(1) of the RTA, a motor vehicle is defined as a “mechanically propelled vehicle intended or adapted for use on a road”—the words “mechanically propelled” are intended to have a very wide meaning and will cover any transmission of power from the engine to the wheels by mechanical means. Similar regulations are to be found throughout the EU, and if further evidence is needed as to just how vague the definition of “mechanically propelled” may be, one needs only to consider the arrest, in 1997, of a paraplegic Scandinavian who was arrested (and tried) for unsafe driving of his wheelchair.

In Section 192(1) of the RTA, the word “road” is defined as any highway and any other road to which the public has access and includes bridges over which a road passes. Public place is a question of fact for the court to determine. In English law, a car park attached to a public house was held, during opening hours, to be a public place as it was attached to a tavern that offered its services to all members of the public, whereas the same car park would not be regarded as a public place if it were attached to a private club [41].

“In charge” is a question of fact, not law. As a general rule, the person remains in charge until he or she takes the vehicle off the road unless some intervening act occurs, e.g., handing keys to another person prevents him or her from retaining control. There is a statutory defense in that a person shall be deemed not to be in charge if he or she can prove that, at the time, the circumstances were such that there was no likelihood of his or her driving the vehicle while the proportion of alcohol in the blood was over the prescribed limit. The fact that the driver was injured or that the vehicle was damaged may be disregarded by the court if it is put forward as a defense. The court is therefore entitled to consider what the position would have been had the defendant not been prevented from driving by damage or injury. Of course, the state must always prove that the defendant was actually driving the car. That may prove difficult if, as is the case in many accidents, there are no witnesses.

Breath Testing

Section 6(1) of the RTA conferred the power to require a breath test only to officers in uniform. The courts have already ruled against a challenge where the officer was not wearing his helmet [42]. In the United Kingdom, the breath test may be taken either at or near the place where the officer makes a request for one. Normally, that would be at the roadside, but not necessarily at the scene of the offense. If an accident occurs owing to the presence of a motor vehicle on a road or other public place, a police officer may require any person who he or she has reasonable cause to believe was driving or attempting to drive, or in charge of the vehicle at the time of the accident, to provide a specimen of breath for a breath test. The test may be taken at or near the place where the requirement was made or, if the police officer thinks fit, at a police station specified by the officer. The North report [29] recommended that type approval and deployment of portable evidential breath testing equipment should be completed no later than the end of 2011. So far this has not materialized. In the United States, roadside breath testing, with non-evidentiary screening devices, is permitted only in "zero tolerance" states, with drivers under age 21 years. Evidential breath machines have been used at the roadside in Australia for many years.

In the United Kingdom, a person failing to provide a specimen of breath without reasonable excuse is guilty of an offense. A reasonable excuse would include someone who is physically or mentally unable to provide a sample, or if the act of providing the sample would, in some way entail risk to health. In most U.S. states, refusal to submit to a breath (or blood or urine) test is admissible as evidence in criminal proceedings, and as a rule, leads to license suspension, even if guilt is not proved in court. In some states, refusal is actually considered a separate crime. This somewhat strange situation comes about because most U.S. states, and most other countries, have per se laws for alcohol: an alcohol level above some preset limit is, by law, proof of intoxication [43, 44].

Section 6 of the RTA allows police prescribed limit of 35 μg of alcohol a driver without a warrant if the breath test is positive, or if the driver fails or refuses to provide a specimen of breath, and the officer has reasonable cause to suspect alcohol in his or her body. Additionally, if an accident occurs owing to the presence of a motor vehicle on a road or public place, and a police officer reasonably suspects that the accident involved injury to another person, then for the purpose of requiring a breath test or arresting a person, the officer may enter (by force if need be) any place where that person is or where the officer reasonably suspects the person to be.

Hospital Procedure

In the United Kingdom, patients at a hospital do not have to produce a breath test or provide a specimen for a laboratory testing unless the practitioner in immediate charge of their case has been notified and does not object on the grounds that the requirement would be prejudicial to the proper care and treatment of the person. In the United States, forensic blood samples can be taken from unconscious patients who are not able to give informed consent. Legislative changes in the UK in the Police Reform Act 2002 give Health Care Professionals (HCPs) similar powers with a few subtle differences in that blood can be taken providing the person has been involved in an accident, the doctor is satisfied that the person is not able to give valid consent (for whatever reason which could include mental health problems), and the person does not object to or resist the specimen being taken [45]. After death, a coroner can order that the blood alcohol level be measured (remembering always that the value measured will be 14% lower than had serum or plasma been measured at a clinical laboratory). In the United States, Medical Examiners and Coroners do not require special permission to measure ethanol (or any drug for that matter) and they do so routinely. Ethanol concentrations in vitreous humor are made and may be introduced in court. However, no fixed relationship between postmortem blood and vitreous concentrations is recognized in law. Additionally, when bodily harm has resulted, or when there is evidence of criminal activity (such as leaving the scene of an accident), then it is within the power of the officer to order that blood be drawn, even if the suspect is unwilling or unconscious.

Police Station Procedure

Police may require a suspect to provide either two breath samples in the UK (other jurisdictions, e.g. NSW Australia, may only require one breath sample), for analysis by means of an approved device, or a sample of blood or urine for laboratory testing. This is usually done at a police station, since it is almost unheard of for a hospital in the United Kingdom or the United States to be equipped with an evidentiary breath testing device. Blood or urine samples can only be collected at a police station or hospital. In the United Kingdom, such a request cannot be made at a police station unless the constable making the requirement has reasonable cause to believe that, for medical reasons, a specimen of breath cannot be provided, or at the time the requirement is made, an approved breath analysis device is not available, or not practical to use, or that the suspected offense is one under Section 3A or 4 of the RTA, and the constable making the requirement has been advised by a HCP that the condition of the person might be due to some drug. This situation does not occur in the United States where, if appropriate staff are available, both blood and urine may be obtained at the police station.

In the United Kingdom, if a specimen other than breath is required, police may demand either a urine or blood test. If blood cannot be obtained as, e.g., might well be the case in a chronic intravenous drug user, then a urine sample must be provided within 1 h of the request for its provision being made and after the provision of a previous specimen of urine. In the United States, urine specimens are generally not considered admissible proof of intoxication. A very large number of studies have shown that the ratio between blood alcohol and pooled urine is highly unreliable and unpredictable [46, 47]. Ureteral urine, on the other hand, has an alcohol concentration 1.3 times greater than blood [33]. Collection of ureteral urine is often attempted at autopsy, but, for obvious reasons, is not an option with living patients. However, blood and not urine can only be taken for Section 5A suspected offenses (see below for more detail).

Breath samples can only be analyzed with approved devices—evidential breath-testing machines (EBM) such as those used in the UK e.g. Intoximeter EC/IR, Lion Intoxilyzer 6000 or CAMIC Datamaster. In Australia this includes models approved by the National Measurement Institute from Drager and Lion (https://www.industry.gov.au/data-and-publications/certificates-of-approval/16-eba). Only officers trained to use the machine are allowed to carry out the intoximeter procedure, and if two breath samples are taken, the lower of two readings is taken. The subject must not have smoked for 10 min or have consumed alcohol or used a mouth spray or mouthwash, taken any medication, or consumed any food for 20 min before the breath test.

If the reading is below the prescribed limit of 35 μg of alcohol per 100 mL of breath, no action is taken unless impairment through drugs is suspected. If that is the case, a forensic physician or other healthcare professional should be called. If the level is between 36 and 39, no prosecution can occur unless there is impairment. If the level is 40 or more, the person is charged with an offense, the previous "statutory option" of the person having the option to replace a breath sample between 40 and 50 μg with a sample of blood or urine having been removed following a recommendation of the North report [29] in the Deregulation Act 2015. Different rules and regulations, but with much the same intent, apply in other countries.

Blood Samples

A blood sample may be required in the following circumstances:

- if the suspect is in hospital; or
- in the police station if:
  - the EBM is not available or faulty,
  - the readings are unreliable with a breath difference more than 15%
  - there is the presence of interfering substances;
  - there is a medical reason for failing to provide breath;
  - it is under the excess specified drugs Section 5A RTA 1988.

It is wise to have a standardized routine for this procedure, if only to help prevent some of the technical defenses that are frequently raised in court. RTA blood alcohol kits are available with all the necessary equipment, and similar kits are sold in the United States, although their use is not mandatory. Whether or not a kit is used, appropriate chain of custody forms must be completed, and the record must reflect that alcohol-containing swabs were not used to cleanse the skin (actually, studies have shown that alcohol swabs contribute negligibly to the final result, but the issue has been raised in court) [48].

The police officer should identify the HCP (doctor, nurse or paramedic), to the person and the HCP should obtain witnessed informed consent. The HCP must then determine whether there are any medical reasons why a sample of blood cannot be taken. It is for the HCP to decide where the sample of blood is taken from. The sample should be divided equally between the two bottles and shaken to disperse the preservative. The bottles should be labeled and placed in the secure containers and caps applied. The driver is allowed to retain one sample, which is placed in an envelope and sealed. The driver is then given a list of analysts. Finally the HCP must ensure that the person is fit to be detained or released.

Under U.S. law, blood may be taken even if the driver objects, providing the driver has been involved in an accident leading to injury, or a crime has been committed. Most U.S. states have statutes that excuse hemophiliacs and patients taking anticoagulants from blood testing [32]. In the UK it is suggested that the HCP should attempt to take blood no more than three times with the patient's consent, case law [49] having determined that the person might have lost confidence in the HCP. If the HCP fails to obtain a blood sample then the driver has fulfilled the statutory requirement.

Impairment Under the Road Traffic Act (Section 4)

The medical examination and procedure to be adopted when it is suspected that a person is unfit through drink or drugs will be considered later in this chapter under Section "Drugs and Driving."

Complex Defenses

Numerous technical defenses have been advocated over the years, and HCPs should be aware of the most common. Failure to provide a sample of breath, blood or urine will be considered separately.

Failure to Provide a Sample of Breath

Unless there is a reasonable excuse, failure to provide a specimen of breath, blood, or urine is an offense under Section 7 of the RTA. In the United States, refusal leads to automatic license suspension and, in some states, may actually constitute a separate crime; police are under an obligation to make sure that drivers are made aware of that fact. The motorist must understand the mandatory warning of prosecution if a specimen is not produced. Failure to understand, at least in the United Kingdom, is a reasonable excuse for the non-provision of a sample [50]. The decision as to whether there is a medical reason not to supply a sample of breath is left to the police officer and is summarized in case law. There is no provision or requirement at that stage for a HCP to be summoned or to give an opinion (Table 14.2).

The role of an Appropriate Adult (AA) (support person) to assist vulnerable individuals with making the decision regarding providing a sample under the Road Traffic Act has recently been clarified. If the individual agrees to provide the sample there is no requirement for an AA to be present. However, if the person detained has declined to provide a sample, the court stated in *Miller v DPP* [55] that there was a very real possibility that the presence of an AA would have calmed the detainee and led him to behave differently and make different choices from those he in fact made.

Table 14.2 Medical reasons for failing to provide a breath sample

Injury to mouth, lip or face
Tracheostomy, rib or chest injury
Respiratory problems such as asthma, acute infections or chronic conditions
Neurological problems, such as facial palsy
Phobia of catching AIDS from using intoximeter [51]
Shock if it renders the driver physically or mentally unable to provide the specimen [52]
Severe alcohol intoxication [53]
Short stature [54]

The AA can assist the detainee in understanding the gravity of his decision not to provide a specimen.

Many cases have been challenged on the basis that the person was unable to blow into the intoximeter due to respiratory problems. Research has now clarified some of these situations. Spirometry has shown that if a person has a forced expiratory volume in 1 s (FEV_1) of less than 2.0 L and a forced vital capacity (FVC) of less than 2.6 L, then that person would generally be unable to use a breath alcohol testing device [56]. A further study of healthy people of small stature (less than 166 cm tall) showed that if their FEV_1, FVC, and peak expiratory flow rate (PEFR) were greater than 2.31, 2.61, and 330 L/min, respectively, then they should be capable of supplying a suitable breath sample [54]. While these papers were particularly useful as most HCPs do not have access to spirometry but do have access to a simple peak flow reading in the custody situation, most of the breath testing machines that were used in the study no longer exist, the respiratory function values cannot be applied to breath testing devices in current use.

A study in Victoria, Australia, showed that persons with an FEV_1 greater than 1.5 L could provide an adequate screening sample on the Lion Alcolmeter SD2 roadside screening device [57] and that, with an FEV_1 greater than 1.0 and FVC greater than 1.75, individuals were able to provide adequate samples on the Drager Alcotest 7110 (as used in Victoria) evidentiary breath testing machine.

A study [58] on the current Lion Intoxilyzer 6000 concluded that some subjects with lung diseases might have difficulty in providing evidential breath samples. The study showed that 9 of the 30 patients with lung disease failed to provide an evidential sample of breath and was performed on patients who had types of lung disease at the severe end of the spectrum. Importantly, what the research also showed was that many patients had sufficient FVCs of more than 1.5 L and should, in theory, have been able to satisfy the machines' requirements of 1.2 L but still could not, in practice, provide a sample possibly because of the long periods needed for exhalation and recovery.

A recent fashionable defense is that the presence of a metal stud through a hole pierced in the tongue invalidates the breath alcohol test because of the prohibition against foreign substances in the mouth and because of the potential for the jewelry to retain alcohol and interfere with the breath test. However, experimental work has shown that the rates of elimination of mouth alcohol were no different in subjects with a tongue stud as opposed to controls and that, for the purposes of breath alcohol testing, oral jewelry should be treated the same as metallic dental work and left in place without affecting the outcome of the breath test [59].

Failure to Provide a Sample of Blood

First, there must be a definite request to provide a sample of blood. In Kuldip Singh Gill v. DPP [60], it was held that a driver could not be convicted of failing to supply a specimen of blood or urine if he or she was not requested to do so. Where the sample of blood is taken from is solely the choice of the HCP (or, in the United States, the emergency room physician). In Solesbury v. Pugh [61], the defendant was found guilty of failing to supply a specimen, as he would only allow a sample to be taken from his big toe, which the doctor was not prepared to do.

It is reasonable for the person to request that his or her own doctor takes the sample of blood, providing this does not delay the sample being taken [62]. In the United Kingdom, if the patient's own doctor and HCP are both present, the person can choose whether the doctor or HCP took the sample. Similar rules apply in the United States, where statutes generally spell out that financial responsibility for such services rests with the driver and not the state. In the United Kingdom, and probably in the United States as well, if a sample of blood is provided but the doctor spills the sample, then the law has been complied with on the basis that removal of the syringe from the vein by the doctor completes the provision of the specimen by the defendant [63]. In the United Kingdom, there is no legal definition on how much blood is required but the specimen must be capable of being divided into two equal parts (to enable the defendant to have a sample independently analysed if they so wished) and it is generally accepted that 5 mL should be sufficient for alcohol. If less than this is obtained, the sample should be discarded and another one attempted or the police officer advised that there is a medical reason why a sample of blood should not be provided and the urine option can then be selected. However, if the offence is for Section 5A a urine option cannot be selected. In the United States, minimum quantities are generally not written into statute. As indicated previously, alcohol swabs should not be used. In the early 1980s, one police force purchased and used swabs containing alcohol with the result that numerous convictions were later quashed [64] (Table 14.3).

Probably, the most common defense for failure to provide a sample of blood is that of needle phobia. If this is alleged, a full medical history should be obtained and enquiry made of whether the person has had blood tests before, whether ears or other parts of the body have been pierced, or whether there have been foreign travel immunizations or any other medical or dental procedure undertaken in which an injection may have been administered. Specific enquiry about the phobia should be made. British appellate judges [65] have stated that "no fear short of phobia recognized by medical science to be as strong and as inhibiting as, for instance, claustrophobia can be allowed to excuse failure to provide a specimen for a laboratory test, and in most if not all cases where the fear of providing it is claimed to be invincible the claim will have to be supported by medical evidence." Stark and Brener [66] stress the importance of having a standardized approach for assessing needle phobia using diagnostic guidelines for a definite diagnosis of a specific phobia and wisely conclude that the best way to ensure a successful prosecution is to obtain a sample, any sample for analysis! Rix [67] also gives some very practical advice for HCPs: be able to distinguish

Table 14.3 Medical reasons for failing to provide a blood sample

Poor venous access
Failure of the HCP to actually take the sample
Needle phobia—need to differentiate between 'dislike' and phobia

between repugnance and phobia, be able to distinguish between unwillingness and inability, document the history and examination with emphasis on the presence or absence of signs of anxiety, and be sure the decision is based on firm medical evidence. Finally, record all this information, specifically note in the police record whether or not a medical condition has been identified, and then communicate this opinion to the police officers verbally.

Another common defense is that of consuming alcohol after the offense—the hip flask defense [68]. It is used almost universally and is based on the fact that while it is unlawful to have an excessive BAC at the time of driving, it is not unlawful to have an elevated blood alcohol at the time of being tested. In the United Kingdom, Section 15(3) of the RTA allows for a driver to prove that he or she had imbibed alcohol after ceasing to drive and that the amount of such consumption was the sole reason for being over the legal limit or unfit to drive, at the time he or she gave a sample for analysis. It will be necessary for a scientist to prove that it was only the post driving consumption that caused the analysis to reveal an alcohol level above the prescribed limit. The quantity of alcohol in the after-drink, the time of intake, and the age, sex, height, and body weight of the driver can all be used to calculate the theoretical expected BAC [69]. Back calculations can only ever be approximate as they are based on average values and while they are reasonable estimates for most people, they may, on occasions, fail to reflect accurately the situation of a particular individual, regardless of whether the calculation is for pre- or post-incident drinking. There are now computer programmes available to calculate these levels.

But the length a person may go to in order to avoid a conviction is illustrated by the case of Mukandiwa [70] who alleged he could not give a blood sample for spiritual reasons. He was registered as a member of the Zimbabwe National Traditional Healers Association, known as Zinatha, and was authorized to practice healing using both traditional and ritual healing. He was a spirit medium, known as a Mhondoro and, as such, had to avoid situations that drove him into a trance. The sight of blood was one such situation. The sight of blood may, he claimed, cause him to go into a trance and become violent, thereby creating serious risk of injury to his health and to others in the police station. This was held to be a reasonable excuse but subsequently overturned in the High Court, on the basis that the defendant could have looked away or closed his eyes!

Illustrative Case *A 42 year old man was arrested on suspicion of driving whilst over the prescribed limit having blown 42 μg/100 mL of breath on the police officer's hand held breath alcohol machine. At the police station, the evidential breath machine was not working and a forensic physician was requested to see him to take a sample of blood. The detainee stated that he could not provide a blood sample because he had a needle phobia. Preliminary examination revealed that his ears were pierced and he had a number of tattoos on his arms. Whilst the piercing and tattoos would suggest that he did not have a needle phobia, a more detailed history* [66, 67] *was taken and it transpired that the detainee had developed a needle phobia following a dental needle breaking during a dental extraction. It was considered* *that he did have a genuine needle phobia and that this was a reasonable excuse for providing a blood sample and the forensic physician advised the police officer to continue the drink/drive procedure with a urine option.*

Failure to Provide a Sample of Urine

If a woman is requested to provide a sample of urine, it is important to have a female officer present as it has been held that because of the embarrassment that it could involve, the refusal to supply a sample of urine could be regarded as a reasonable excuse [71]. Any embarrassment at having to urinate in front of an officer of the same sex is not regarded as a reasonable excuse for not having supplied a specimen. However, in order to pass urine, it is necessary to relax the bladder sphincter muscles; anxiety causes muscle tension and difficulty in micturition. Self-conscious feelings elicited when others are present may possibly interfere with the ability to relax the bladder sphincters. This is known as avoidance paruresis, sometimes called shy bladder, bashful bladder, or bladder shyness and may be implicated in a defense of failure to provide a sample of urine without reasonable excuse (Table 14.4).

In summary Jones and Logan [69] have outlined a number of driving under the influence (DUI) defenses—see Table 14.5. If the subject has consumed alcohol or other drink or used a mouth spray, mouthwash, drug or medication or has eaten, inhaled or taken anything, or has brought anything back from the stomach, practice in the UK is to wait for 20 min before commencing the evidential breath sampling

Table 14.4 Medical reasons for failing to provide a urine sample

Drugs such as opiates which may result in difficulty passing urine [72]
Neurological problems affecting the bladder
Presence of a catheter
Embarrassment at having to provide a sample in front of a member of the opposite sex
Chronic dialysis patient

Table 14.5 DUI defenses

Drinking after the offense—the hip flask defense
Laced drinks
Rising blood alcohol concentration
Pathological conditions or trauma
Endogenous alcohol and the auto brewery syndrome
Use of alcohol swabs for skin disinfectant
Drug-alcohol interactions
Alleged interfering substances in breath
Mouth alcohol and the use of mouthwash preparations
Regurgitation and the gastro-esophageal reflux disease
Infusion of blood or other liquids during surgical emergency treatment
Dentures and dentures adhesives

procedure (MGDD/A 2017). If the subject has smoked (including the use of an electronic cigarette) in the last 5 min, wait 5 min before test.

Illustrative Case *A 28-year-old asthmatic woman was seen to drive a car erratically and was arrested on suspicion of driving whilst over the prescribed limit of alcohol. She gave a history of previous opiate misuse for which she had been maintained on 60 mLs of Methadone per day for the past six months. At the police station she was noticeably wheezy and the police officer elected to request a sample of blood. Two attempts at taking a blood sample were unsuccessful because she had poor venous access due to previous intravenous injections of heroin. The police officer was advised to request a sample of urine for alcohol but the detainee was subsequently unable to provide a sample of urine. She was charged with failure to provide a specimen of urine without reasonable excuse. At the subsequent trial, an expert witness opined that as Methadone can have an effect on the bladder sphincter this was a reasonable excuse* [72] *and the defendant was found not guilty.*

Postmortem Alcohol Measurements

This topic has been reviewed in depth by Pounder and Jones [33]. High postmortem alcohol concentrations do not imply that impairment was evident during life. Of 32 alcohol dependent individuals presented at an emergency room for medical treatment, only 23 had apparent behavioral abnormalities, 6 were confused, and 3 were drowsy, even though the mean alcohol concentration was 313 mg/100 mL (range 180–450 mg/100 mL) [73]. Alcohol can be measured in a number of tissues, but the most accurate picture is usually obtained when multiple sites are sampled, e.g., vitreous, gastric contents, blood, and urine (particularly if ureteral urine is available), and the alcohol concentrations compared.

Since the eye is anatomically isolated, putrefaction is delayed, and there is little problem with postmortem redistribution, vitreous measurements can be used to confirm values obtained from whole blood and urine, to distinguish postmortem alcohol production from antemortem ingestion, and to determine whether BACs were rising or falling at the time of death. Vitreous contains more water than blood so that the blood/vitreous alcohol ratio is less than 1. Ratios greater than 1 suggest that death occurred before equilibrium had been reached, i.e., blood alcohol was still rising [74]. Vitreous alcohol concentrations can be related to blood concentrations; however, there is so much intraindividual variation that extrapolation in an individual case is probably unwise and unsound scientifically.

As previously mentioned, serum and plasma contain more water than whole blood, and it follows that the alcohol content of the former will be 10–15% higher than the latter. Since postmortem measurements are made with whole blood, and since the water content of the cadaver begins to decrease almost immediately after death, estimating antemortem values with any precision is difficult, especially if only blood has been sampled. However, if samples from multiple sites are obtained, and vitreous, blood, and urine (urine as it is being formed contains 1.3

times as much alcohol as whole blood) are all analyzed, it may be possible to make a reasonable estimate of what the alcohol concentration was at the time of death [33].

Drugs and Driving

The Scale of the Problem

Increasing alcohol levels are associated with increased risk of accidents, but fatigue, illicit drug use, and the use of prescription medication can also increase risk. In recent years there has been a great deal of research to estimate the prevalence of the use of drugs in the driving population. In the United Kingdom in 1997, over 860,000 breath tests for alcohol were carried out with a refusal (presumed positive) rate of 12% (103,000) [75]. During that same period, the Forensic Science Service dealt with only 1850 drugs/driving submissions. In a 2-week period in August 1996, the Forensic Science Service received 270 blood specimens for testing for driving with excess alcohol. Further examination revealed that 18% contained one or more drugs and, of those that fell below the legal alcohol limit, a further 18% were positive for drugs. If this 18% figure were applied to those 103,000 cases in 1997, over 18,000 cases would have been identified in which drivers had drugs in their body [76].

In October 1999, the U.K. Department of Environment, Transport and the Regions completed a 3-year study into the incidence of drugs in road accident fatalities [77]. There were a total of 1138 road user fatalities including drivers, riders of two-wheeled vehicles (34 of them cyclists), passengers in vehicles, and pedestrians; over 6% tested positive for medicinal drugs, 18% for illicit drugs (mainly cannabis), and 12% for alcohol.

In this study, urine was tested by immunoassay for the following drugs: alcohol, amphetamines, methylamphetamines (including ecstasy), cannabis, cocaine, opiates, methadone, LSD, benzodiazepines, and tricyclic antidepressants (TCAs). The incidence of medicinal drugs likely to affect driving had not significantly changed from the 1985 to 1987 study. However, illicit drug taking in drivers had increased sixfold in percentage terms, and there was a comparable increase among passengers. In addition, an increasing number had taken more than one illicit drug. In 1997, drugs were detected in approximately 90% of samples submitted to the U.K. Forensic Science Service for analysis (Table 14.6). Research in Scotland [78] showed that 6% of drivers aged between 17 and 39 claimed to have driven at some time while under the influence of drugs and 3% in the last year.

Table 14.6 Type of drug detected in samples submitted to the FSS in 1997

Amphetamine	13%	Methylamphetamine	3%
Cannabis	28%	Cocaine	6%
Opiates	16%	Methadone	7%
Benzodiazepines	24%	Others	3%

In Europe the Driving Under the Influence of Drugs (DRUID, Alcohol and Medicines) Project performed in 13 countries over the period 2006–2011 showed that alcohol (>0.1 g/L) was detected in 3.5% of drivers, illicit drugs (mainly cannabis) in 1.9% and medicines (mainly benzodiazepines and some opioids) in 1.4% [79]. There have been studies on road traffic fatalities in the UK with an increase in the presence of illicit drugs from 3% [80] to 18% [81]. More information is becoming available worldwide about the prevalence of driving under the influence of drugs [82].

Effects of Different Drugs on driving

Cannabis

Numerous studies have been undertaken to examine the effects of cannabis on driving. One large meta-analysis of over 150 studies showed that cannabis impairs the skills important for driving, including tracking, psychomotor skills, reaction time, and performance, with the effects most marked in the first 2 h after smoking and with attention, tracking, and psychomotor skills being affected the most [83]. The study also showed that impairment is most marked in the absorption phase as opposed to the elimination phase, and that frequent cannabis users become less impaired than infrequent users. These are, for the most part, older studies, done during the 1970s. Impairment is dosage-dependent, and externally observable symptoms, e.g., impairment of psychomotor skills or the impression of absent-mindedness, disappear quickly during the early elimination phase. One study [84] carried out with volunteer marijuana smokers who were actually driving found that the main effect of marijuana was to increase lateral movement of the vehicle moderately within the driving lane on a highway [85, 86]. A UK study [87] offered further support for the view that, under the influence of cannabis, users are acutely aware of their impairment, but attempted to compensate for their impairment by driving more cautiously. Recent US studies [88] showed that the association between cannabis use and crash risk to be inconsistent. One study estimated the increased crash risk from cannabis usage to be 1.83 times that of an unimpaired driver, while another study found no association between risk of being involved in a crash and cannabis use.

The results of another study [89] suggest that alcohol and marijuana-induced impairment differ in some important respects. This study compared the effects of three doses of cannabis and alcohol (placebo, low and high doses), both alone and in combination, on the driving performance of young, novice drivers, and more experienced drivers. Alcohol was administered as ethanol (95%) mixed with orange juice in doses of approximately 0, 0.4, and 0.6 g/kg. Cannabis was administered by inhalation of smoke from pre-rolled cannabis cigarettes that contained 19 mg delta-9-THC. When the simulated driving performance of 25 experienced and 22 inexperienced drivers was tested under the nine different drug conditions, high levels of cannabis generally induced greater impairment than lower levels, while alcohol at the doses used had few effects and did not produce synergistic effects when combined with cannabis. Both cannabis and alcohol were associated with increases in speed and lateral position variability; high-dose cannabis was associated with decreased mean speed, increased mean and variability in headways, and longer reaction time, while in contrast alcohol was associated with a slight increase in mean speed. Given the limitations of the study, it is of great interest to further explore the qualitative impairments in driving performance associated with cannabis and alcohol separately and how these impairments may manifest in terms of crash characteristics. These results may force some reworking of commonly accepted dogma. Finally, there is the issue of testing accuracy. Controlled experiments [90] done with chronic cannabis smokers, living in a locked metabolic ward, show without any reasonable doubt that substantial whole blood THC concentrations persist multiple days after drug discontinuation in heavy chronic cannabis users. Whether or not neurocognitive impairment actually occurs with low blood THC concentrations, and how long it takes to return to normal performance, are not known.

In forensic drug driving cases the level of THC, the active metabolite, and THC-OH the initial metabolite, and THC-COOH the final metabolite, should be measured. High level of THC relative to THC-COOH is indicative of recent smoking of the drug whereas the opposite, when THC-COOH is higher, suggest that cannabis was consumed some time ago. Since the impairing effects of cannabis wear off relatively quickly, this information is very important for the interpretation of the toxicology result. The persistence of blood THC levels maybe higher and persist longer in long term heavy cannabis users [91].

Opiates

Single doses of narcotics can have marked effects on performance, such as reaction time, but the effect of a dose of opiates on driving will depend on the history of usage and whether tolerance has developed. The actual blood level will therefore not necessarily be useful in defining impairment. However, most studies of opiates among regular users suggest that they do not present a hazard or exist as a significant factor in driving. One study [92] compared driving ability between patients stabilized on methadone and those beginning or receiving an increased dose of methadone. A key finding appeared to be that patients on a maintenance dose have no psychomotor impairment in relation to driving ability; thus, clients on a methadone program should not be considered impaired in their ability to perform complex tasks such as driving a motor vehicle. In the United Kingdom, persons on a stable methadone program who have not abused other drugs for 1 year, and who have clear urine drug screening tests on a regular basis, are allowed to hold a driving license subject to annual review [6]. However, it should be remembered that users of heroin are also prone to significant use of other psychoactive drugs, such as cocaine, alcohol, and tranquilizers, all dangerous when it comes to driving.

This problem is illustrated by a study [93] from Germany. Thirty-four methadone substitution patients, all of them volunteers, were subjected to a battery of psychological tests and the results compared with those of a control group. The methadone group ($n=34$) consisted of 25 men and 9 women (age range 18–38 years). Urine samples of approximately two thirds of the methadone patients tested positive for multiple drug use, the most frequent drug ($n=14$) being cannabis. On psychological testing, the methadone substitution patients achieved lower scores on almost all tests. Performance deficits were particularly conspicuous in sustained attention, sensori-motor coordination, and reaction capability. Deficits were minimal in the 12 methadone patients who were, in fact, taking only methadone. The authors conclude that, under certain conditions, long-term methadone maintenance patients under strict medical supervision do not suffer significant driving impairment, providing that no other drugs have been taken.

These findings were further emphasized in a research paper from Norway [94], where patients enrolled in an opioid-assisted rehabilitation program are also permitted to drive a motor vehicle. Researchers investigated drivers who had been apprehended, who had methadone in their blood. Cases of driving involving methadone alone were very rare. In most cases, benzodiazepines were found with amphetamine type drugs, the most common illegal substance, followed by cannabis derivatives. No correlation between methadone concentration as judged by the Norwegian clinical test of impairment (CTI) was seen.

Heroin may be taken in a variety of ways smoking, by injection, snorting and it has a short half-life of a few minutes before being converted to an active metabolite 6-acetylmorphine (6-AM) and morphine. The active metabolite 6-AM also has a short half-life of about 10–20 min and is therefore only detected in blood for 1–2 h though it may remain in urine for 6–10 h. The presence of 6-AM in blood or urine indicate heroin usage but the period of detection is dependent on a number of variabilities including the heroin dosage, the route of administration and frequency of usage. Presence in urine gives no indication of blood level or impairment.

Cocaine and Methamphetamine

Although the argument often goes unchallenged in court, all drugs do not, by definition, produce impairment. Even though some U.S. states define “being under the influence” as synonymous with the presence of any drug, some drugs do improve performance. In fact, low-to-moderate acute doses of cocaine and amphetamine can be expected to increase positive mood, energy, and alertness, especially in nontolerant individuals [95]. It has been known since World War II that use of d-amphetamine can increase the ability to sustain attention over prolonged periods when performing monotonous tasks. For that very reason, radar operators and pilots of both Allied and Japanese armies were issued supplies of amphetamine. Many of the performance tasks related to driving can be improved, at least in the laboratory, by treatment with stimulants [96]. Although the results of one retrospective autopsy study suggest that methamphetamine users seem more likely to be involved in traffic accidents [97], a driving simulator study [98] of young people who had taken Ecstasy (MDMA) showed that basic vehicle control is only moderately affected but risk taking is increased. It seems likely that abrupt discontinuation of either drug in a chronic user could result in driving impairment, but that situation has never been tested [85]. Very large doses can result in toxic psychosis with symptoms indistinguishable from paranoid schizophrenia, a condition that is extremely unlikely to improve driving performance.

Cocaine and methamphetamine are different drugs, even if they do share some common modes of action. There have been only a few experimental studies on the acute effects of cocaine on performance and these are mostly restricted by methodological limitations, such as the administration of low doses. For example, controlled studies of human volunteers given modest doses of cocaine (0.58 mg/kg) failed to demonstrate significant impairment [99]. In most of the studies that have been performed in relation to driving impairment, it was not possible to calculate the associated risks because the number of positive cases was too low. However, other studies [100] clearly demonstrate that drivers under the influence of cocaine are significantly more likely to be responsible for a crash than drivers who are not under the influence of this drug (2.3 OR, 95% CI: 1.4–4.0).

Musshoff and Madea [101] measured cocaine and its principle metabolite, benzoylecgonine, in the blood of German drivers arrested for driving impairment. The finding of cocaine and benzoylecgonine indicates that cocaine was taken very shortly before a blood sample was taken. When blood samples were collected into sodium fluoride containing tubes (which prevent cocaine breakdown), the mean cocaine concentration was 836 ng/mL while that of benzoylecgonine was 669 ng. Given the short half-life of cocaine (in the order of 1 h), concentrations measured in hundreds of milligrams prove recent ingestion, as does the simultaneous detection of both cocaine and benzoylecgonine. However, the detection of benzoylecgonine in isolation cannot be construed as proof of cocaine impairment as one would expect benzoylecgonine to remain present in the blood for more than 24 h. If impairment does occur, the duration of impairment has not been measured. Any per se legislation on cocaine-induced impairment would require the presence of actual cocaine, not any of its metabolites. Once again any symptoms and signs of drug use, as well as evidence of actual impaired driving, are important in the overall conclusions as the same blood concentrations can have significantly different effects on an individual depending on whether they are a regular user and tolerance has developed.

Sedative-Hypnotics

Benzodiazepines impair psychomotor performance in nontolerant individuals, generally in a dose-dependent manner. Most of the widely prescribed benzodiazepines increase lateral lane movement and slow response time to a lead car's change in speed. Several of the benzodiazepines (oxazepam 50 mg, flurazepam 30 mg, and lormetazepam 2 mg) predictably impair driving the morning after. Diazepam (15 mg) impaired performance on a clinical test for drunkenness, which comprised 13 tests assessing motor, vestibular, mental, and behavioral functioning [102, 103]. One study [104] showed a clear relationship between dose of benzodiazepines and risk of impairment, which the authors felt probably supported a limit for benzodiazepines and driving as low as within the "therapeutic range."

Acute doses of many benzodiazepines slow response time in simple or choice visual reaction time tests and impair attentional performance and cause deficits that are not due to sedation. In fact, the impairment of sustained attention and vigilance in benzodiazepine users seems to be the direct result of some, as yet uncharacterized, direct action on perceptual sensitivity [85].

Z-drugs such as zopiclone, zolpidem and zalepon have the potential to impair driving secondary to sedative effects. Patients starting such drugs should be warned of the possibility of side effects. Research has shown a decline in driving ability with impaired concentration and coordination [105].

Multiple Drug Use

Polydrug use is common and can result in complex interactions, with the drugs having additive, antagonistic, or synergistic effects. Alcohol is commonly consumed in addition to abused drugs. In a study on alcohol and cannabis [106], it has been shown that when they are administered together, the result was one of additive impairment. This finding was confirmed in a UK study [107]. In the laboratory setting, however, simultaneous administration of alcohol and cocaine seems to minimize alcohol-related deficits [96]. The tendency towards polydrug abuse complicates the issue of determining which drug, if any, is responsible for impairment. In the study by Musshoff cited above [101], more than 50% of those arrested had other drugs besides cocaine present.

Antidepressants

There are many side effects associated with the use of the TCAs, e.g., amitriptyline, that are relevant to the ability to drive, such as blurred vision, slow visual accommodation, disorientation, and eye-hand coordination; the most important are the induction of drowsiness, lethargy, and sedation. An analysis of 500 road traffic accidents showed that victims who had taken TCAs had a relative accident risk 2.2 times greater than non-TCA users and that patients using TCAs with a daily dose greater than or equivalent to amitriptyline 125 mg had a sixfold increase in road traffic crash risk [108]. The newer antidepressants drugs of the 5-HT reuptake inhibitor class, e.g., fluoxetine, paroxetine or the selective serotonin and noradrenaline reuptake inhibitors (e.g., venlafaxine), have been shown to not generally affect driving performance and are safe for use by patients who drive [109].

Over-the-Counter Preparations

An increasing number of drugs can now be bought over the counter from pharmacies. Many of these preparations, e.g., cough mixtures and decongestants, contain drugs that can cause sedation, particularly the older antihistamines, e.g., chlorpheniramine and diphenhydramine. The newer non-sedating antihistamines such as terfenadine and astemizole generally do not appear to impair driving. However, one study that measured driving performance across differing doses of terfenadine found that performance was impaired at very high doses (240 mg), stressing the need to establish the behavioral effects of drugs over a range of doses [110]. The second-generation group of antihistamines is less lipophilic than the previous generation and thus cross the blood–brain barrier less readily, accounting for the lower levels of sedation observed with the newer drugs. Thus, while the second-generation antihistamines generally produce less sedation than first-generation compounds, if therapeutic doses are exceeded, the so-called non-sedating antihistamines become sedating and can impair driving.

Assessment in the Field by Police

In the United Kingdom, if a police officer stops a driver, for whatever reason, and feels the driver is unfit to drive, it is highly likely that a roadside breath test will be carried out. That is not the case in the United States, where field breath testing is only permitted in some states, and then only for drivers under the age of 21 [32]. The laws of the United States also prevent random breath testing. Under the Fourth Amendment, searches and seizures must be reasonable. Stopping a vehicle is a seizure, but it may be construed as reasonable if the police officer has a justifiable suspicion that an offense is being committed. The procedures American officers follow in DUI cases are surprisingly similar to the procedures under the United Kingdom Section 4 RTA. To gain powers to carry out further tests, officers in most U.S. states first have to be satisfied that the driver is impaired. This then gives them the probable cause to carry out subsequent tests similar to the Section 4 procedure to prove impairment. It is quite possible that some of the newer technologies might be applied in the field to drugs other than alcohol. However, concentrations of THC and THC-COOH in oral fluid show a large variation and there is no correlation between oral fluid and urine samples from cannabis abusers. Thus, detailed information about time interval between drug use and sample collection is needed to interpret the oral fluid results properly, and the value of testing saliva has yet to be convincingly demonstrated [111].

If breath testing is negative, impairment due to drugs or medical illness must be considered. It was previously the case that in the United Kingdom, police traffic officers received little or no training in the recognition of signs and symptoms of drug effects. However, a pilot study [112] was carried out in England, Wales, and Scotland in 1999, whereby police officers were trained to perform roadside impairment tests; this study showed that forensic analysis confirmed the presence of a drug in 92% of the drivers who were suspected of taking a drug, who had failed the Field Impairment Tests (FIT), and who had provided a sample. As a consequence, FIT has been introduced across the United Kingdom with some police forces pursuing it more vigorously than others. This contrasts dramatically with the United States, where in 1979, the Drug Recognition Expert (DRE) Program was introduced. Police officers were trained to observe and document known indicators of drug use and impairment.

In 2004, the Railways and Transport Safety Act (2003) was enacted which introduced in the UK, a Code of Practice for Preliminary Impairment Tests (PIT) making it a legal requirement for motorists to undertake a roadside Preliminary Impairment Test [113]. The Act also provided for the Provision of a Preliminary Drug Test by way of sweat or saliva, though it took some time before these achieved type approval.

In the UK a PIT:

> *'may be a test of any type provided it meets the requirements and objectives of the Act and is administered in accordance with a Code of Practice used by the Secretary of State for the purpose.'*

The PIT currently includes:

- Pupillary examination
- The Modified Romberg Balance Test
- Walk and Turn Test
- One Leg Stand
- Finger-Nose test.

The codes state it is not possible to ‘pass’ or ‘fail’ all or any one of these tests; at the conclusion of the test the constable shall be able to form an overall opinion considering together what they know of the subject’s driving, their demeanor and anything learned in general conversation or observation, together with the subject’s performance during the test and the observation of the pupillary examination, whether the person is impaired to drive a motor vehicle through drink or drugs. The important factor here is observation where possible of actual driving or evidence from witnesses of the manner of driving.

In the United States instead of breath testing, a series of Standardized Field Sobriety Tests (SFSTs), including test of psychomotor and divided attention skills, is conducted. The following tests are administered when alcohol-induced impairment is suspected: Walk and Turn Test, One Leg Stand, and the Horizontal Gaze Nystagmus Test. If drug use is suspected, a Romberg Balance Test is also administered. Unlike chemical tests, where refusal to submit to testing may result in immediate license suspension, drivers in the United States are not legally required to take any SFSTs; if the driver submits, however, the results can be introduced as additional evidence of impairment.

Various kinds of tests are used. They are designed to assess the individual’s balance and coordination as well as the ability to follow simple instructions, i.e., to divide attention between multiple tasks. They are as follows:

- Horizontal Gaze Nystagmus: nystagmus may be caused by any number of conditions, but its presence could indicate drugs or alcohol.
- Walk and Turn: nine steps heel to toe are taken in one direction, and then the individual turns and repeats the process in the other direction. Eight impairment indicators are measured; if two of the eight are present, impairment would be indicated.
- One Leg Stand: the subject has to stand on alternate feet for 30 s while counting aloud. Failing two of the four recognized indicators indicates impairment.
- Romberg Balance Test: the subject stands with eyes closed and estimates a period of 30 s during which body sway is estimated. Some drugs alter the body’s internal clock and make the test subject act faster or slower than they normally would. The test allows for a tolerance of ±10 s.

If impairment is identified, and alcohol is suspected, the driver undergoes breath testing and a similar procedure to the United Kingdom Section 5 RTA procedure is carried out. However, if drugs are suspected, the police officer calls for a Drug Recognition Expert (DRE) to carry out a more detailed examination.

The DRE uses a 12-step procedure:

1. Breath alcohol test: this is carried out by the arresting officer; if the reading is not consistent with the degree of impairment, the DRE is called in.
2. Interview with the arresting officer: the purpose is to ascertain baseline information including the circumstances of the arrest, whether an accident occurred, whether drugs were found, and if so, what they looked like.
3. Preliminary examination: the purpose of the preliminary examination is to determine whether there is sufficient reason to suspect a drug offense and, if possible, exclude any underlying medical problems. General observations and details of any current medical problems are ascertained, and the first pulse measurement is taken. If no signs of drug influence are found, the procedure is terminated; if any medical problems are found, a medical assessment is obtained, and if drugs are still suspected, a full assessment is carried out. If at any time during the assessment a serious medical condition is suspected, a medical opinion will be obtained.
4. Eye examination: the driver is assessed for horizontal gaze nystagmus, vertical gaze nystagmus, and convergence.
5. Divided attention tests: once at a police station, the Romberg Balance Test, Walk and Turn Test, One Leg Stand Test, and Finger to Nose Test are carried out. These are all examples of divided attention tests designed to assess balance and movement tests in addition to the subject's ability to remember instructions.
6. Vital signs examination: blood pressure, temperature, and a second recording of the pulse are performed.
7. Darkroom examination: pupil size is measured in room light and then in near total darkness, using both indirect artificial light and direct light. The mouth and nose are also examined for evidence of drug use.
8. Muscle tone: limb tone is assessed as some drugs and some drug-related syndromes (particularly the potentially deadly Serotonin Syndrome) cause rigidity, whereas others, e.g., alcohol, cause flaccidity.
9. Injection sites examination: the purpose is to seek evidence of intravenous or injection drug abuse. A third pulse reading is also taken.
10. Interrogation: a structured interview about the use of drugs is carried out.
11. Opinion: based on all the previous assessments, the DRE forms an opinion as to drug impairment and also the type of drug causing the problem, the legal standard being a reasonable degree of certainty.
12. Toxicology testing: at the same time, samples are obtained for toxicologic examination; of either a blood or urine is collected for analysis of common drugs.

Initial studies suggesting very high sensitivity and specificity for DRE examination [114] have not been confirmed in controlled laboratory studies. The results of the few studies that have been performed suggest that the accuracy of DRE assessment in general may not be sufficiently good to provide evidence in court fairly [85, 86]. Several field studies have indicated that a DRE's opinions were confirmed by toxicologic analysis in 74–92% of cases when DREs concluded that suspects were impaired. However, published controlled trials, in which blood levels were measured before and during DRE examination, have shown that except in the case of alcohol, DRE assessment agreed with toxicology findings only 32–44% of the time. Evidence has also been obtained [115] to indicate that older people are unable to perform the SFSTs as well as younger people.

Roadside Screening Tests

There are other options for roadside screening tests. Both sweat and saliva have been used [116]. Devices are already available, and some have been approved by the U.S. Department of Transportation for the testing of commercial drivers. Even non-volatile molecules appear in the breath, and the feasibility of even detecting amphetamine by breath testing has been demonstrated [117]. It is very likely that the scope of roadside breath testing will expand in the future. The mere detection of a drug does not prove impairment unless, of course, the jurisdiction has *per se* laws whereby the detection of drugs at some predetermined level is ruled, by law, to be proof of impairment. Roadside drug screening tests are acceptable to the public—a UK study [118] found that 98% of drivers were in favor of the principle of roadside drug screening and found the test methods of saliva or forehead perspiration generally acceptable. In the UK the North Report [29] recommended the earliest practicable type approval and supply to police stations of preliminary drug screening devices and currently two are in use in the UK; the Draeger 5000 and the Securetec Drug Wipe 3S S303G which both test for cannabis and cocaine.

Medical Examination Under Section 4, RTA

In the United Kingdom Section 7(3)(c) of the RTA states that:

> *'the suspected offence is one under Section 3A or 4 of this Act and the constable has been advised by a medical practitioner that the condition of the person required to provide the specimen* ***"might"*** *(author's emphasis) be due to some drug.'*

It is for the court to decide whether the driver is unfit to drive on the evidence before it.

Whether the examination is carried out by a HCP in London, or an emergency room physician in San Francisco, the aim of the examination is to exclude any medical condition other than alcohol or drugs as the cause of the driver's behavior. The differential diagnosis is very wide and includes head injury, neurological problems (e.g., epilepsy, stroke, cerebral tumor, multiple sclerosis), metabolic problems (e.g., hypoglycemia), hepatic or renal failure, and mental illness. The procedure should include introductory details, full medical history, and clinical examination. The Faculty of Forensic and Legal Medicine has developed a pro forma for this purpose (see http://www.fflm.ac.uk for the most recent version). Similar forms are not available in the United States, but there is nothing to prevent any emergency department in the United States from drafting and providing a similar document. Even if no special form is provided, most of the relevant material will have been (or at least should be) recorded in the emergency department record.

Introductory Details

These should include the name, address, and date of birth of the driver and the name and number of the police officer as well as the place and date the examination took place. In addition, various times including time a health care professional was contacted, time of arrival at police station/hospital, and time the examination commenced and ended are recorded. The HCP should note the result of any roadside breath test and/or EBM reading; roadside drug screening test; information from the arresting officer—in particular the manner of driving, why the detainee was stopped by police, etc.; the results of the Preliminary Impairment Test (PIT); and the Police Risk assessment in custody. Informed consent should be obtained.

The North Report [29] recommended that appropriately trained HCPs could undertake assessments under Section 4 RTA and this was enacted in the Deregulation Act 2015. The FFLM [119] developed a series of competencies for clinicians undertaking this type of assessment.

Full Medical History

Details of any current medical problems and details of recent events, particularly whether there was a road traffic collision that led to the arrest, should be recorded. Past medical history (with specific reference to diabetes, epilepsy, asthma, visual and hearing problems), past psychiatric history, and alcohol and drug consumption (prescribed, over the counter, and illicit) should be noted.

Interpretation of the findings on clinical examination are only possible if a detailed medical history is taken: physical, mental, drug (prescribed and illicit), as poly drug usage is the norm and dependence and tolerance will need to be considered.

Illustrative Case *A 34-year-old woman crashed her car into a tree. She was assessed by paramedics at the scene and other than a bruised lip, she had no other injuries. A roadside breath test revealed a breath alcohol level of 121 μg/100 mL of breath and she was then arrested on suspicion of driving whilst over the prescribed limit. At the police station she was tearful and distressed and was unable to provide a sample of breath for evidential purposes. In view of the lip injury the police officer decided that this was a reasonable excuse for failing to provide an evidential sample of breath. The HCP was asked to see her to take a blood sample but first decided to* *assess her fitness for continued detention. This revealed that she was significantly depressed and had been drinking and tried to kill herself by crashing the car into a tree. She stated that on release she would make a further attempt at killing herself. A blood sample was taken but it was deemed that she was not fit for subsequent detention and her admission was arranged to a psychiatric hospital for treatment of her severe depression.*

Clinical Examination

This should include general observations on demeanor and behavior, gait, a note of any injuries, speech abnormalities, the condition of the mouth, and any smell on the breath. The cardiovascular system should be examined and, as a minimum, the pulse, blood pressure, and temperature all should be recorded. Evidence of drug use should be sought, e.g., needle marks. Examination of the eyes should include noting the state of the sclera, the state of the pupils including size, reaction to light, convergence, and the presence of both horizontal or vertical nystagmus. The use of drug combinations may result in normalisation of physical signs e.g. normal sized pupils with the use of opiates and cocaine. HCPs need to be aware of 'soft signs' such pupillary reaction to light and the fact that pupil size is also dependent on lighting conditions.

The mental state should be assessed and a sample of handwriting maybe requested. Fitness for detention is of paramount importance, and any person who is not fit to be detained because of illness, injury, or drug and/or alcohol intoxication (toxic effects) and withdrawal should be transferred to hospital and not subjected an assessment under Section 4 RTA. If the person refuses to consent to an examination, it is prudent to make observations on his or her manner, possible unsteadiness, etc. and make written note of these.

Previously it was recommended that the HCPs should repeat a series of divided attention tests, as outlined in Codes of Practice [113]. Despite the fact that these tests are widely applied, Field Impairment Tests (FIT) have never been scientifically or statistically calibrated using a control group of subject drivers who had not taken any drugs. It is therefore not possible to ascertain how any individual driver would perform in the absence of possible impairment due to drugs. Neither is there any clear definition of how many components of the five tests used need to be abnormal before a judgement of impairment can be made. Arguably it would be much better to train both police and HCPs with regard to recognizing the common symptoms and signs of illicit drugs, alcohol and misused prescription drugs (Table 14.7).

Correlation between symptoms and signs of drug use and actual presence of drugs has been found to be low with true positives in subjects who had taken the drug very recently and/or in high quantities [120].

A survey of Police Surgeons' opinions within Strathclyde Police demonstrated concerns regarding the introduction of SFSTs with the Walk and Turn Test and the One Leg Stand Test causing the highest levels of concern [121]. A major review of the evidence by O'Keefe [122] concluded that these tests are not reliable and valid

Table 14.7 Preliminary Impairment Test (UK) in relation to clinical examination

Test	Observations	Clinical relevance
Pupil examination	Size of pupils	Variation in size with age, lighting conditions, alcohol and/or drugs
	Eyes watery	Sign of opiate withdrawal
	Eyes display reddening	Sign of conjunctival infection, cannabis usage, etc.
Modified Romberg Balance Test	Test for balance	Romberg Test is positive if sways when eyes closed. Indicates impaired proprioception or vestibular dysfunction. Balance[a] affected in cerebellar disease[b] and with CNS depressant drugs.
	Internal clock	Perceptual disturbance may be seen with a range of drugs with the internal clock altered (fast or slow) and not related to the type of drug used
One Leg Stand	Balance and counting out loud	No equivalent examination in the clinical field
Finger-nose test	Test of depth perception and balance	Tests co-ordination Past pointing in cerebellar disease[b] Other tests that might be used: Dysdiadochokinesis Heel knee shin Finger tapping
Walk & Turn	Observation of walking, balancing, and processing instruction	Observation of gait Heel-toe walking may be difficult for older patients (due to the frequent coexistence of other medical conditions) even in the absence of neurological disease. Gait depends on tone, strength, balance[a], sensation and coordination. Presence of abnormalities including ataxic gait seen with CNS depressant drugs such as alcohol

[a]Balance has three components: visual, proprioceptive and vestibular
[b]The cerebellum fine tunes motor activity and assists with balance. Dysfunction results in a loss of coordination and problems with gait

tests of drug related impairment to drive and are too difficult for some groups of drug-free individuals to perform.

At the end of the examination, the clinician should decide whether there is a 'condition' present that might be due to some drug. However opinions differ on what constitutes a '*condition*' due to a drug [123]. In the case of very short-acting drugs, the observations of the police officer or other witnesses can be of crucial importance. An individual has been found guilty of driving while unfit through drugs entirely on the basis of the officer's observations and the results and opinion of the toxicologist—the police surgeon was not called to give evidence [124]. Similarly, if the police officer reports that the person was swerving all over the road, proving good evidence of impaired driving, but the HCP later finds only minimal physical signs, this may be sufficient to indicate that a condition may be present due to some short acting drug, e.g., cannabis, and that it is appropriate to proceed to the next part of the procedure. Case law [125] in the UK has held that the medical practitioner (and now the HCP) is entitled to take into account all relevant information relating to the person's earlier condition in determining whether there 'is a condition present which might be due to a drug'. In the United States physicians rarely if ever see individuals arrested under suspicion of impaired driving. Under U.S. law, if a suspected felony has occurred, the driver has no right to refuse testing and a physician may be called upon to draw blood for testing.

The HCP should inform the police officer whether there is a condition present that might be due to a drug and if so, the police officer will then continue with the blood/urine option as in Section 5 RTA, previously described. Consent will need to be obtained for a blood specimen. On this occasion, 10 mL of blood should be taken and divided equally into two septum-capped vials as the laboratory requires a greater volume of blood for analysis because of the large number of drugs potentially affecting driving performance and their limited concentration in body fluids; indeed, if the driver declines the offer of a specimen, both samples should be sent.

As a means of further validating FIT as an effective means of detecting drivers who are impaired due to drugs, the University of Glasgow carried out important research [126]. The drivers stopped under suspicion of impairment who were under the legal alcohol limit, but still considered impaired, were offered a FIT test. If they failed this test, they were considered as a suspect drug driver and examined by a forensic physician and a forensic sample obtained and analyzed if appropriate. Those who "passed" a FIT assessment were asked to voluntarily supply a sample of saliva, which was analyzed for drugs. In relation to the use of FIT, the assessment of impairment by a police officer using the test was supported by the clinical examination of the forensic physician in 77% of cases. Biological samples were only analyzed in 65% of this group, but significant drug use was confirmed in 94% of them. It was not possible to obtain biological specimens from drivers where the forensic physician did not corroborate the opinion of the arresting officer (23% of cases). Importantly, the study confirmed that oral fluid samples could be used to identify drugs in drivers, but of concern was the fact that, of those who were stopped and judged to be unimpaired by the police officer, 71% had drug-positive saliva samples.

In Victoria Australia [127], forensic physicians with relevant qualifications and experience act as experts for the court by reviewing all the evidence of impaired driving, the police Preliminary Impairment Test, the forensic physician's assessment, and toxicological results and provide an opinion. Very few expert opinions have been challenged in court. However, there were a number of inconsistencies in the physical examination with the drugs eventually found on toxicological examination; cases where the individual were barely conscious where a formal assessment should not even have been considered; and missed medical and psychiatric conditions.

Medical Examination Under Section 5A, RTA

Despite the introduction of impairment tests in the UK, convictions for drug driving remained low. The North report recommended that the UK Government should actively pursue research to determine the levels of active and impairing metabolites of the following controlled drugs: opiates, amphetamines, methamphetamine, cocaine, benzodiazepines, cannabinoids, methadone and ecstasy (MDMA).

An expert panel [128] determined the respective levels based on a road safety risk based approach but following a consultation, the UK Government set a 'lowest accidental exposure limit' for the drugs most associated with illegal use and 'road safety risk based limits' for eight controlled drugs. Legislation was introduced creating a new offence making it unlawful to drive with any of the listed drugs in the body in excess of the prescribed level.

'Accidental exposure'—zero tolerance approach	Threshold limit (µg/L)
Benzoylecogonine	50
Cocaine	10
Delta-9-tetrahydrocannabinol	2
Ketamine	20
Lysergic acid diethylamide (LSD)	1
Methylamphetamine	10
Methylinedioxymethamphetamine (MDMA)	10
6-monoacetylmorphine (heroin)	5

In addition, the UK Government also set levels for certain prescription drugs based on a 'road safety risk based' approach.

'Medicinal' limit—road safety risk based approach	Threshold limit (µg/L)
Clonazepam	50
Diazepam	550
Flunitrazepam	300
Lorazepam	100
Methadone	500
Morphine	80
Oxazepam	300
Temazepam	1000
Amphetamine	250

On 2 March 2015, a new law was introduced as Section 5A of the RTA 1988 via the Crime and Courts Act 2013 making it a new offense to drive with certain controlled drugs, including some prescription drugs, above specified limits, there being no need to prove impairment in Court. Although the legislation has been introduced UK wide, it has not yet been enacted in Scotland or Northern Ireland. There is a statutory defense for drivers who have taken medicines containing specified controlled drugs in accordance with medical advice.

Thus, with the use of a drug screening device, there is no longer a need for a HCP's opinion whether the person has a *'condition that might be due to a drug'*. The levels are set in blood only as levels cannot be set in urine reliability and a urine sample cannot be used as an option for Section 5A cases.

Preliminary results [129] of the new legislation showed increasing convictions for drug driving with more prosecutions under the new Section 5A than for pre-existing

Section 4 impairment drugs and a conviction rate of 98%. There appeared to be no evidence that users of prescribed medicines that fall into those categories of drugs covered by the legislation had been adversely affected by the new regulations.

Further research continues to try and identify if there are any other alternative biological matrices for use as an evidential sample for drug driving. An expert panel [130] recommended that consideration should be given to expand the list of type-approved screening tests to include, in addition to cannabis and cocaine, the amphetamine type drugs (methamphetamine and MDMA) and ketamine to reflect the growing use of these compounds in the driving population and that hair testing may be an appropriate matrix for re-licensing decisions as it would enable the determination of a history of past exposures to illicit or medicinal controlled substances.

Conclusions

There is an urgent need to reduce drink driving globally as this is a major contributory factor for road traffic collisions with resulting deaths and seriously injured drivers and pedestrians. Since 2014, 22 additional countries have amended their laws on one or more key risk factors to bring them in line with best practice, covering a potential additional one billion people or 14% of the world's population [1]. In the UK there have been repeated calls for Government to reduce the drink drive limit and for a review of policy to reduce unnecessary deaths [131]. There are three approaches to establishing a legal framework for drug driving—zero tolerance, an impairment standard, and a per se approach with many jurisdictions using a combination [132]. The introduction of limits for drug driving has overall simplified the process.

Key Points

- Many medical conditions affect driving. HCPs should be aware of the requirements relating to assessing fitness to drive so they can advise patients accordingly.
- Drink driving limits vary by age, jurisdiction, and type of vehicle.
- It is essential to be aware of the drink and drug driving procedures in your jurisdiction and have a process for taking samples in the police station or hospital.
- There is vast case law on drink and drug driving and it is important to be aware of common examples.

Self-Assessment Exercises

1. How would you advise an insulin dependent diabetic who wanted to apply to be a bus driver?
2. List the factors that affect the absorption, distribution, metabolism, and excretion of alcohol in the body?
3. What are the drink drive limits for alcohol in breath, blood and urine in your jurisdiction?
4. What are the common medical reasons for failing to provide a sample of blood?

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