# 2 Strength and Limits of Conventional Forensic Medicine

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## 2.1 Introduction

Since about 20 years Forensic postmortem imaging was developed systematically at first in Bern, then whole Switzerland and now worldwide [1–5]. Richard Dirnhofer, the father of "Virtopsy",[1] summarizes the scientific development of postmortem imaging techniques as follows [1]:

> *It was against the background of rapid technological advances in various imaging techniques, that at the turn of the century, the academic concept of the "Virtopsy" research programme was realized at the University of Bern in Switzerland. The aim of this project has been to develop a minimally invasive autopsy procedure in which evidentially relevant findings are obtained from a corpse predominantly by means of medical imaging methods. Depending on the individual case and the specific issue involved, this leaves, the option open to perform a conventional autopsy to acquire further relevant facts, such as histological, toxicological and bacteriological examinations.*
>
> *The international impact of this idea has been reflected in an exponential increase in scientific publications around the world dealing with forensic radiology. For instance, the recently published study by M. Baglivo et al. showed a tenfold increase in the volume of publications compared to the turn of the millennium, when the "Virtopsy" project started.This academic "hype" in the field of postmortem radiology has had a very positive influence on the attractiveness of radiology for the new generation of academics in forensic medicine.*
>
> *In short, the results of these numerous publications documents that postmortem imaging is not only equal to autopsy in many respects but that this method can even achieve better results than conventional autopsy procedures. This has also called into question the status of conventional autopsy as the "gold standard" for obtaining and recording forensic medical findings.*

He questions already if the traditional autopsy is still the "gold standard" for obtaining and recording forensic medical findings.

The purpose of this chapter is not to argue for or against traditional autopsy or postmortem forensic imaging but to briefly address evolution, importance and decline of the traditional autopsy.

The importance of the different imaging techniques in solving different forensic questions has been outlined especially by Dirnhofer [1–3] and Grabherr [4, 5].

There is no doubt about the importance of forensic imaging.

## 2.2 Technique, History and Tasks of the Autopsy

The modern autopsy has been defined as follows [6]:

> An autopsy is the systematic external and internal examination of a body to establish the presence or

[1]The term "Virtopsy" is a neologism comprising the words "virtual" and "autopsy". It is used for imaging in Forensic Medicine, especially postmortem imaging (CT, MRT, surface scanning, Angiography).

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absence of disease by gross and microscopic examination of body tissues. The pathologist makes a surgical incision from shoulder to shoulder and from the midpoint of the shoulder-to-shoulder incision to the pubic bone. The skin is reflected, and each organ in the chest, including the neck structures, abdomen and pelvis, is removed and carefully examined. An incision is also made from the mastoid bone on the right to the mastoid bone on the left, and the scalp is pulled forward and the bony cap removed to reveal the brain. The brain is removed and examined. The pathologist takes a small sample or biopsy of all tissues and archives them in formalin to maintain them for future references.

For hospital autopsies, depending on the list or permissions given by the person qualified to give permission, tissues and organs may be retained for study, research, or other investigations. The pathologist submits small 2 × 2 cm sections of tissue to the histology laboratory, where thin slices a few microns thick are subjected to chemical treatment to preserve them. The tissue blocks are shaved, so that a thin layer can be mounted on a glass slide and stained with dyes to differentiate cells. The pathologist can recognize diseases in the stained tissue. Medicolegal autopsies are conducted to determine the cause of death; assist with the determination of the manner of death as natural, suicide, homicide, or accident; collect medical evidence that may be useful for public health or the courts; and develop information that may be useful for reconstructing how the person received a fatal injury. [6]

Autopsies have been performed to:

- Establish the cause of death.
- Assist in determining the manner of death (i.e. homicide, suicide).
- Compare the premortem and postmortem findings.
- Produce accurate vital statistics.
- Monitor the public health.
- Assess the quality of medical practice.
- Instruct medical students and physicians.
- Identify new and changing diseases.
- Evaluate the effectiveness of therapies such as drugs, surgical techniques and prosthesis.
- Reassure family members.
- Protect against false liability claims and settle valid claims quickly and fairly [7].

Bowman and Anderson et al. also summarized the uses of autopsy [8].

| Bowman (1983) | Anderson et al. (1979) |
|---|---|
| Assisting in development and quality assurance of new technologies, procedures and therapies<br>Quality assurance for clinical diagnosis and treatment<br>Improving accuracy and value of vital statistics<br>Source of organs and tissues for transplantation<br>Evaluation and distribution of insurance benefits<br>Monitoring and identifying environmental disease<br>Medical education<br>Forensic pathology<br>Disclosing the nature of an individual death<br>Risk management<br>Reassurance to family<br>Explaining unknown or unanticipated complications of disease<br>Identifying communicable diseases | Instrument of quality assessment of medical care by peer review<br>Continuing education of physicians<br>Provision of reliable database on causes of death and disease<br>Recognition of harbingers of disease<br>Grief counselling for family<br>Identification of communicable diseases<br>Forensic pathology<br>Monitoring and identifying environmental disease<br>Materials and problems for basic research<br>Medical education |

**Table 2.1** Types of autopsy (according to [9])

| |
|---|
| • Anatomic autopsy |
| – Structure and function of human body |
| – Andreas Vesalius (1514–1564) |
| – Great progress in the sixteenth to eighteenth centuries |
| • Clinical autopsy |
| – Cause, locus, aetiology, pathogenesis of disease |
| – Giovanni Battista Morgagni (1682–1771) |
| – Marie François Xavier Bichat (1771–1802) |
| – Carl von Rokitansky (1804–1878) |
| – Rudolf Virchow (1821–1902) |
| • Forensic autopsy |
| – Cause and manner of death |
| – Causality of external violence for death |
| – Live birth or stillbirth determination |
| – Medical malpractice |
| – Johannes Bohn (1640–1718) |
| – Johann Ludwig Casper (1796–1864) |
| – Eduard von Hofmann (1837–1897) |

There are three types of autopsy: the anatomic autopsy, the clinical autopsy and the forensic autopsy (Table 2.1). The anatomic autopsy studies the structure and function of the human body. The clinical autopsy studies the cause, locus, aetiology and pathogenesis of disease, and was the main method for medical research in the nineteenth and early twentieth centuries. The forensic autopsy is essential in determining the cause and manner of death and the causality of external violence for death.

The anatomic autopsy was largely developed at Italian universities, especially at the University of Padua [9–20]. Andreas Vesalius (1514–1564) published his famous series of books on human anatomy, *De Humani Corporis Fabrica Libri Septem.*

Clinical autopsy also developed at the University of Padua [14, 16, 18–20]. Giovanni Battista Morgagni (1682–1771) performed autopsies to study the cause and locus of disease and wrote his famous book *De Sedibus et Causis Morborum* based on his studies. Morgagni looked for diseases of the organs as the cause of death.

Marie Xavier Bichat (1771–1802) studied tissues ("membranes") as the cause of disease and death [21].

The history of the development of pathology at the Paris Hospital was well described by Erwin Ackerknecht in 1967 and later by Michel Foucault in his book, *The Birth of the Clinic* (1994) [10, 11, 22, 23].

Further major developments in clinical pathology were achieved in Vienna by the pathologist Carl von Rokitansky (1804–1878), who personally conducted more than 30,000 autopsies at a small morgue in the neighbourhood of the Vienna General Hospital [11, 24–29]. Rokitansky wrote famous handbooks on both general pathology and special pathology. Furthermore, he wrote a book on atrial septal defects and built a new Institute of Pathology, which still exists today.

Further developments in clinical pathology were made in Berlin by Rudolf Virchow, who studied the cell as the cause of death and disease [9, 11, 28, 30, 31].

Rudolf Virchow (1821–1902) was the founder of cellular pathology. He also founded the Museum of Pathology, which still stands in the Charité area of Berlin, and which displays specimens from Virchow's collection [31]. Virchow was not only responsible for the ongoing development of clinical pathology, but also for developing the methods of forensic autopsy. He published a book on autopsy techniques, *Die Sections-Technik im Leichenhause des Charité Krankenhauses*, which was very important for the standardization of autopsy rules in practice. Similar books were published in other German countries and in Austria. Meanwhile, the Council of Europe published recommendations for the international harmonization of autopsy rules.

Handbooks on autopsy techniques are available worldwide [24, 32–40].

Clinical autopsy was the main method of medical research in the nineteenth and early twentieth centuries [8, 28]. Many diseases have been discovered or critically clarified through autopsy. A partial list of these diseases is shown in Table 2.2.

Even in the twentieth century new diseases were discovered by the systematic analysis of autopsy results (f.i. AIDS).

The forensic autopsy was developed in the nineteenth century [9, 14, 30, 41]. However, as early as the seventeenth century professors of forensic medicine working at the University of Leipzig were requesting autopsy rather than wound inspection to determine the cause and manner of death. In Germany, Johann Ludwig Casper (1796–1874) played an essential role in the development of forensic medicine and forensic autopsy. Casper wrote his well-known handbook of forensic medicine based on his personal experiences at autopsies. The morgue at the Institute of Forensic Medicine in Berlin was modelled after the morgue at the Institute of Forensic Medicine in Paris. In Austria, Eduard von Hofmann (1837–1897), who wrote a famous handbook on forensic medicine as well as an atlas of forensic medicine, was instrumental in the further development of forensic medicine and forensic autopsy.

As in clinical pathology, forensic pathology revealed new autopsy findings and allowed critical evaluation through further systematic observations and experiments, including

- Hydrostatic lung test.
- Contrecoup lesions of the orbit in cases of falling on the back of the head.
- Simon's bleedings (haemorrhages of the intervertebral disk of the lumbar spine) in cases of hanging.
- Inner knee sign in death due to hypothermia.

**Table 2.2** Partial list of diseases discovered or critically clarified through autopsy since 1950 (according to [8])

| Cardiovascular lesions | Bronchopulmonary lesions | Gastrointestinal lesions |
|---|---|---|
| • Tricuspid valve disease due to metastasizing carcinoid tumour | • Alveolitis (diffuse alveolar damage, shock lung, respiratory distress syndrome) | Whipple's disease |
| • Understanding of congenital heart lesions leading to modern surgical treatment | • Oxygen toxicity | Protein-losing enteropathy |
| • Atheromatous embolism | • Pneumocystis pneumonia | Congenital intestinal atresia |
| • Asymmetric cardiac hypertrophy | • Infantile respiratory distress syndrome (hyaline membrane disease) | Pancreatic cystic fibrosis |
| • Dissecting aneurysm and variations thereon | • Legionnaire's disease | Vascular insufficiency syndromes and haemorrhagic enteropathy |
| • Primary cardiomyopathy | • Pulmonary alveolar proteinosis, desquamative pneumonia | Protein and potassium loss from villous adenoma |
| • Subaortic muscular stenosis | • Diseases resulting from inhalation of industrial dusts: asbestosis, berylliosis, bagassosis, silo-filler's disease | |
| • Rheumatoid disease of aorta and aortic valve | • Lipid pneumonia | |
| • Complications of cardiac surgery | • Diffuse interstitial fibrosis | |
| • Diseases of the cardiac conducting system | | |
| • Idiopathic hypertrophic subaortic stenosis | | |
| • Cardiomyopathies | | |
| • Mitral valve prolapse | | |

From Hill and Anderson (1996)

– Patterned contact entrance wounds.

According to autopsy rules which were mainly developed in the nineteenth century in various countries the gross autopsy findings have to be described according to the following criteria [15, 24, 32–34, 38]:

**Description of gross autopsy findings:**

1. Location and form of organs, situs
2. Height and weight (of the body, of organs, etc.)
3. Surface
   (a) Organs surface
   (b) Serosa, mucosa, adhesions
4. Consistency
5. Coherence, consolidation
6. Cut surface
   (a) Structure
   (b) Colour
   (c) Fluids, congestion, smear
7. Odour

The pathologist has to use all his senses to make a complete description of autopsy results.

The gross tissue alterations are evaluated according to the following criteria:

**General gross tissue alterations due to disease:**

- Blood content
  – Acute anaemia
  – Chronic anaemia
  – Acute hyperaemia
  – Chronic venous congestion
- Obstruction of blood
  – Thrombosis
  – Thrombembolus
- Necrosis
  – Ischaemic necrosis
  – Haemorrhagic necrosis
  – Caseous necrosis
  – Gangrenous necrosis
- Oedema
- Haemorrhage

- Dystrophia
  - Cloudy swelling
  - Fatty degeneration
- Hyaline
- Amyloid
- Pigments
  - Anthracosis
  - Haemosiderin
  - Melanin
  - Bile pigment
  - Lipofuscin
  - Malaria pigment
  - Ochronotic pigment
  - Heavy metals
  - Iatrogenic pigment
- Inflammation
  - Serous
  - Catarrhalic
  - Fibrinous
  - Purulent
  - Haemorrhagic
  - Necrotizing
  - Gangrenous
- Reparation
- Calcification
- Tumours, neoplasms
  - Macroscopic difference benign and malign tumours
  - Primary tumour/metastasis
  - Carcinoma/sarcoma

By a traditional autopsy all these gross tissue alterations can be evaluated.

## 2.3 Autopsy as Quality Control of Clinical Medicine

The autopsy is still today the gold standard for clarifying the cause and manner of death and is much superior to an external examination taking into account the clinical history of the patient [24, 36, 42–49]. Autopsy-detected errors in clinical diagnosis can be classified as follows [47, 48, 50, 51]:

- **Major errors (class II)**
  Clinically missed diagnoses involving a principal underlying disease or primary cause of death
- **Class I errors**
  Major errors that, had they been detected before death, might have affected patient prognosis or outcome (at a minimum, allowed discharge from the hospital alive)

According to a study by Goldman et al. [43], class I errors have remained relatively stable over the centuries. According to a meta-analysis by Shojania et al. [48], class I errors are found today in 8–10% of autopsies. The diseases most frequently associated with major discrepancies between antemortem and postmortem diagnoses are listed in Table 2.3. In many clinical disciplines, autopsy reveals additional information that has important clinical relevance (Table 2.4).

In very specialized and well-equipped hospitals like the University Hospital Zurich class one errors are now as low as 2% [50, 51, 53]. This decrease of class one errors is to some part due to improved imaging techniques.

However, the autopsy rate has markedly declined over time in Europe and the United States [6, 49, 54–57]. The clinical autopsy rate in Germany is now below 2% and the forensic autopsy rate is stable at about 2% (Table 2.5) [54].

The autopsy is of special importance in medical malpractice cases [58–62]. Without autopsy, toxicology and histology [63] clinicians are walking in the fog as far as malpractice claims, especially adverse drug events are concerned.

**Table 2.3** Diseases most frequently associated with major discrepancies between antemortem and postmortem diagnoses (according to [42])

| Autopsy diagnosis | % Discrepancy |
|---|---|
| Pulmonary embolism | 46.8 |
| Peritonitis | 45.1 |
| Postoperative haemorrhage/infection | 37.9 |
| Vascular insufficiency of the intestine | 37.2 |
| Lung abscess | 34.1 |
| Renal infarct | 31.6 |
| Metastatic carcinoma | 30.6 |
| Alzheimer's disease | 30.0 |

Adapted from ref. [42]

**Table 2.4** Percentage of cases in which autopsy revealed additional information and the percentage of those cases in which the additional findings were clinically relevant (according to [52])

| Discipline | Cases with additional information (%) | Diagnostic or clinical relevance (%) |
|---|---|---|
| Internal medicine | 82.1 | 26.1 |
| Surgery | 68.0 | 64.7 |
| Neurosurgery | 66.7 | 40.0 |
| Anaesthesiology/intensive care | 93.8 | 60.0 |
| Paediatrics | 50.0 | 100 |
| Neonatology | 36.4 | 25.0 |
| Cardiac surgery | 89.1 | 26.0 |
| Total | 74.8 | 32.9 |

From Ref. [52]

**Table 2.5** Autopsy frequency in some European countries (according to [54])

| Country | Year | Total (%) | Clinical pathological (%) | Forensic (%) |
|---|---|---|---|---|
| Great Britain | 1999 | 17.3 | 2.1 | 15.2 |
| Sweden | 1992 | 22 | 16 | 6 |
| Finland | 1992 | 31.1 | 14.2 | 16.9 |
| Denmark | 1992 | 16 | 13.6 | 2.4 |
| Germany | 1999 | 5.1 | 3.1 | 2.0 |
| Germany | 1994 | 6.1 | 4.2 | 1.9 |

## 2.4 Decline of the Clinical Autopsy

The reasons for the decline of the clinical autopsy are several [15, 32, 36, 44, 45, 49]. The famous Austrian/German pathologist Herwig Hamperl (1899–1976), who worked in Vienna, Berlin, Prague, Salzburg, Marburg and Bonn, wrote an autobiography where he published the number of autopsies performed at the different locations where he worked and the number of examined biopsies [56] (Fig. 2.1). While at the beginning of his career in Vienna there was a high autopsy rate and few biopsies were examined by the end of Hamperl's career there was a reverse picture: a low autopsy rate (about 700 per year at the Bonn University Hospital) and a high biopsy rate. Compared to the times of Hamperl the rate of clinical autopsies decreased further dramatically.

It has to be kept in mind that the decline of the autopsy rate, especially the non-forensic autopsy, started centuries before the implementation of postmortem imaging into forensic and clinical pathology practice.

Other reasons for the resistance against autopsy are [28]:

- Loss of the important role of autopsy in exploring morphological conditions of virtually every disease
- Clinical pathology vs. autopsy pathology (biopsies instead of autopsies)
- Development of individual rights
  - Consent is necessary to perform autopsy
  - Questions about who can provide consent

Furthermore, pathologists are not paid adequately for either clinical or forensic autopsies and lost interest in performing autopsies.

Furthermore clinicians are resistant against autopsies for different reasons:

- Autopsies seem not necessary in times of high tech-medicine since cause of death and underlying diseases have already been diagnosed sufficiently
- Fear for medical malpractice claims

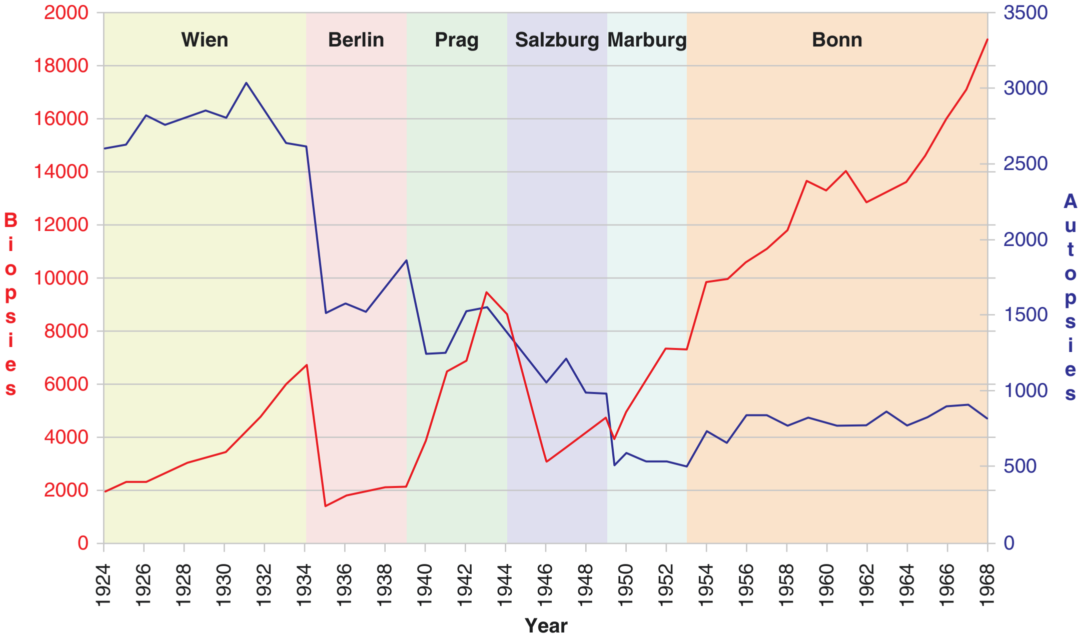


**Fig. 2.1** Herwig Hamperl (1899–1976) worked in various cities (Vienna, Berlin, Prague, Salzburg, Marburg, Bonn). Number of autopsies performed and number of examined biopsies by location. The number of autopsies decreased, the number of biopsies increased considerably

– They don't want to share their DRG-claims (money for treating the patients) with the pathologist
– Too much time delay until the final report of the pathologist is finished

## 2.5 Limitations of Autopsy Compared to Radiology

In recent years limitations of autopsy relative to radiology have been outlined. The purposes of forensic radiology can be summarized as follows [1–3]:

- Patient identification
- Gender determination
- Body length measurement
- Discrimination of individual features (dental, intracorporeal)
- Documentation
- Revealing foreign material (bullets, inserted foreign bodies)
- Identification of injuries and organ disease (to determine cause and manner of death)
- Evaluating vitality of sustained injuries
- Forensic reconstruction
- Education
- Research

According to Dirnhofer, this method of documenting forensic findings is investigator independent, objective, and noninvasive and provides qualitative improvements in forensic pathologic investigation, because digitally stored data can be recalled at any time to provide fresh, intact topographic and anatomic-clinical information. Dirnhofer et al. described the systematic limitations of classical autopsy as follows:

- No complete autopsy from top to toe
- Destructive method—anatomy destroyed by preparation
- Preparation and documentation of findings impaired in cases of putrefaction
- Preparation results depend on lighting conditions
- No 3D presentation of results

- Contamination of specimens for further analysis (toxicology, etc.)
- “Bloody” photographic documentation
- Conventional autopsy not accepted by relatives or some religions

Advantages of the noninvasive or minimally invasive approach achieved with postmortem surface scanning and multi-slice computed tomography as well as magnetic resonance imaging over current forensic examination techniques include

– Precise, objective and clear documentation of forensic findings for the court
– Calibrated 3D documentation of findings
– Quality assurance through digital data archiving and transfer
– Reduction of psychological trauma for the next-of-kin
– Improved judicature in cultures with low autopsy acceptance [1–3]

The advantages of imaging according to Dirnhofer are summarized in Tables 2.6 and 2.7.

**Table 2.6** Advantages of imaging (according to [3])

| Imaging methods | Advantage of application in the justice system |
|---|---|
| Objective data collection; “Mechanized” objectivity without human influence | Independence from the specific forensic pathologist. Considerably easier to obtain second opinions |
| Better reproducibility | Presentation of the findings themselves as evidence—not just the expert report |
| “Bloodless” documentation | “Nontraumatic” presentation of findings in the courtroom |
| Teleforensics | Interpretation not just by two pairs of eyes but by multiple investigators |
| True-to-scale 3-D facsimile of the body as an item of evidence | Real-data forensic reconstructions are very accurate (e.g. road accidents, shootings, stabbings) |
| Postmortem angiography | Clear definition of sources of bleeding in all trauma cases and in investigations into treatment errors<br>Clear information following cardiac and vascular interventions. 3-D record of bleeding in the soft tissues |
| Postmortem CT scans with simultaneous surface documentation | Possibility of making 3-D morphometric comparisons, accurate in colour and scale, between the shape and size of injuries and the alleged weapon. Independent of place and time<br>Reconstruction of road accidents and homicides based on real data. Contamination-free 3-D comparisons, joint examination, and processing of a case by forensic scientists, police, and judiciary<br>Introduction of the 3-D model of the deceased/injured person into the 3-D model of the crime scene |
| Clear detection of accumulations of gases in the body | Avoidance of gas embolisms in arteries and veins and escape of air into the chest, often overlooked because they are not visible at autopsy. These findings can be relevant to the cause of death |
| Cause célèbre | Clear information given to the public |
| Detection of foreign bodies, parts of projectiles, weapons | Clear localization of foreign bodies<br>Reliable image-guided asservation |
| Non-destructive procedure | No debate over autopsy on religious grounds |
| Reliable recording of findings in areas difficult to dissect: head, neck, pelvis and peripheral vessel regions | Additional information from findings to establish the cause of death and forensic reconstruction |
| Ability to archive a “facsimile” of the corpse for use as evidence | Additional and subsequent expert opinions always possible at a later date (e.g. cremation, no need for exhumation) |

**Table 2.7** Documentation of findings and expert assessment using imaging (according to [1])

| Allocation of responsibilities | |
|---|---|
| 1. External examination—surface scan | → 3D visualization—improved |
| ↓ | |
| 2. Imaging of internal findings (CT, MR, …) | → Non-destructive, whole body—improved |
| ↓ | |
| 3. Storage of data as a true-to-scale 3D model—**signed only by radiographer (MTRA)** | → New, most valuable element (for critical discussion as defined by K.R. Popper) |
| ↓ | |
| 4. Capture of findings using the Schwarzacher perception method—overall view, detail, naïve, viewing, leafing through the visual memory | → Identical to autopsy |
| ↓ | |
| **4a.** Recording of findings by radiographer | → Identical to autopsy |
| ↓ | |
| **4b.** Multiple-investigator principle of capturing findings | → Improved through possibility of teleradiology |
| ↓ | |
| 5. Written documentation of findings by reading—**signed solely by radiologist** | → Remains the same—corresponds to current autopsy report |
| ↓ | |
| 6. Joint (forensics and radiology) preparation of forensic diagnostics from the findings—**signed jointly by radiologist and forensic specialist** | → Improved—corresponds to the summary autopsy report or the forensic pathological diagnosis |
| ↓ | |
| 7. Interpretation of the diagnosis and findings for expert report, taking account of all the circumstances (E. von Hofmann, premises, evidenced facts such as information pool, examination of the scene, toxicology, histology, etc.)—**signed solely by forensic specialist** | → Remains unchanged—corresponds to the forensic report. Does, however, enable more effective critical examination based on Item 3 within the framework of the assessment of evidence, second opinions, decisive expert reports |

## 2.6 Can Postmortem Imaging Replace the Autopsy Completely

Especially for trauma victims the value of postmortem imaging not only for the documentation of injuries but also for clarifying cause and manner of death has been shown [64–67].

In an unselected autopsy material the classical autopsy is still superior to postmortem imaging.

In a recent investigation, Roberts et al. [68] concluded: "Our findings identify important shortcomings of cross sectional imaging in the diagnosis of cause of death in adults and provide the evidence needed to refine imaging techniques and enable them to be safely introduced into autopsy services". Indeed, the major discrepancy rate between autopsy-determined and radiologically determined cause of death was 32% (26–40) for computed tomography and 43% (36–50) for magnetic resonance imaging. These findings indicate that postmortem imaging is not superior to a simple external examination. Postmortem imaging is essential for documentation, but to clarify cause and manner of death the traditional autopsy remains at least at the present moment the gold standard for unsolved cases.

**The benefits of the autopsy fall into seven broad categories** [15]**:**

1. Benefits to physicians and health care organizations
2. Benefits to the family of the deceased
3. Benefits to public health
4. Benefits to medical education
5. Benefits to medical discovery and applied clinical research

6. Benefits to basic biomedical research
7. Benefits to law enforcement and jurisprudence [15]

Finkbeiner et al. further elaborated the benefits of autopsy [15]:

1. Benefits to physicians and health care organizations
   (a) Establishment of final diagnoses and cause of death
   (b) Correlation of physical and laboratory findings with pathologic changes of disease
   (c) Autopsy is the gold standard for evaluating the accuracy of diagnosis and the outcome of therapy
   (d) Autopsy provides critical data for medical quality assurance
   (e) Autopsies may also reduce hospital and physician malpractice risk
   (f) Autopsy may contribute to accurate billing
2. Benefits to the family of the deceased
   (a) identification or definition of hereditary or contagious diseases
3. Benefits to public health
   (a) Detection of contagious diseases
   (b) Identification of environmental hazards
   (c) Contribution of accurate vital statistics
4. Benefits to medical education
   (a) Education of students in medicine and other health-related disciplines
5. Benefits to medical discovery and applied clinical research
   (a) Modern molecular techniques coupled with and supplementing postmortem examinations have identified diseases related to emerging and re-emerging infectious agents
6. Benefits to basic biomedical research
   (a) Provides investigators with normal and diseased human tissues for research
7. Benefits to law enforcement and jurisprudence

There is no doubt that in the future postmortem imaging will fulfil these benefits as well.

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