Disaster Medicine Pocket Guide: 50 Essential Questions

Work of the French Society of Disaster Medicine

Henri F. Julien
Editor

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SFMC
Paris, France

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SFMC: The French Society of Disaster Medicine (*La Société Française de Médecine de Catastrophe*)

Was founded in 1983 by those who, two years before, had established for the first time in France and in Europe a university course for disaster medicine.

The objective of the French Society of Disaster Medicine (SFMC) is to gather members of learned societies who are concerned with disaster prevention and management, wide-scale emergencies, and uncommon health crises: field workers, administrative and technical directors, experts, and volunteers from diverse backgrounds.

Presently, SFMC regroups French and foreign members: doctors, paramedics, pharmacists, veterinarians, members of emergency medical services, health administrators, community employees, directors of security and prevention services, and members of concerned associations. SFMC is also opened to include international members, in particular, the French-speaking ones.

Over the past almost 40 years, SFMC has effectively contributed, through its works and publications, and its symposiums and meetings, where it exchanged experience and know-how, research results and technical acquisitions, to enhancing the concept of disaster medicine in France as well as abroad.

SFMC publishes four times a year, in Elsevier, the "*Revue de médecine de catastrophe*", the official organ of the society. The active website of it is www.sfmc.eu. SFMC has its own database,

which includes data on disaster medicine and uncommon emergencies; such data are reserved for its members. A trimestral report "*la Lettre de la SFMC*" is regularly sent to its members.

SFMC slogan: "*Not to anticipate is already to moan*".
Leonardo Da Vinci

Preface

"French Doctors" is a very well-known concept that has travelled beyond borders for many years now. This concept recounts the French-style humanitarian field action facing distressed population affected by civil wars, natural disasters, outbreaks, migration flows….

France is specialized in rapid medical action in emergency and disaster situations.

In addition to emergency medicine, the concept of "disaster medicine" rapidly became clear in order to deal, in France and abroad, not only with natural disasters but also with large-scale accidents and threats. Many teams were dispatched to Sri Lanka, Mexico, Dakar, Central America, Pakistan, and Hanoi. "Disaster medicine" has recently gained much expertise in response to the uncommon health events which have a long-term impact on healthcare services. COVID-19 pandemic is a good example.

A huge reserve of civilian health personnel has been created as well as a dedicated healthcare supply chain in kits. Missions have been set to provide additional support in both equipment and staff and to handle long distance medevacs by air for the 12 French overseas territories with a population of over two million people.

This guide adopts an explanatory approach in order to summarize the French expertise: how to plan and respond to predictable/unpredictable events with a strong destabilizing effect on civilian populations.

Civilian and military medical experts wrote this guide and address it to decision makers and field players. Its goal is to share

knowledge and operating procedures in order to promote cooperation and cross-border interoperability not only in Europe, but also worldwide.

Action plans highlight the importance of building rapidly deployable strategic reserve stocks, of having a hierarchical operational organization, and of promoting a prehospital medical management integrating medical and psychological support.

This guide is a user-friendly tool in pocket format.

> ***« Les crises sont des choses qui arrivent régulièrement. Le grand avantage, c'est qu'en général on en sort renforcé »*** **Jacques Chirac** ("*Crises happen regularly. The great advantage is that we generally emerge from them stronger*". Jacques Chirac, former French President)

Dr Catherine Bertrand Vice president of SFMC

Paris, France Henri F. Julien

Warning

Disaster medicine descends from war medicine, and has been practised, taught, and made official in France over the past 40 years or so.

Its university course applies and completes prehospital emergency medicine, which was established in France in 1965, with the specificity of disaster as defined nowadays.

What are the main characteristics of strategies, tactics, and techniques needed to deploy in case of mass violence situations such as disasters?

Over the past 20 years, several medical teams have been able to apply the practices learnt from this course even abroad.

This operational experience should be taken into account by all emergency services assigned as potential responders.

However, in addition to those potential tasks, the emergency staff already have their "everyday" emergency practice where every clinical presentation has its standard care protocol. Both fieldwork and emergency unit work have their norms.

Major disasters bring along changes of the paradigm, i.e. when "the balance of powers" between disaster consequences and the immediately available means is no longer in favour of applying "standard procedures": those changes are imposed by:

- A big number of victims, unusual clinical presentations, and the required quantity and quality of the resources are no longer those of everyday work;
- The responding medical teams cannot rely on the daily logistic support or the ergonomic conditions of common practice anymore, which represents a different emotional climate.

In such conditions, doctors should deal with the consequences of this unusual context. Few examples of inappropriate reactions are:

- Absence of triage with all its consequences on the evolution of the therapeutic chain;
- The relentless treatment of a patient deemed not urgent while just few metres away there are other patients who should benefit from urgent life-saving measures;
- The use of materials and medications as in common practice without taking into account whether backup supplies would arrive in time;
- Lack of knowledge on the treatments to use for the disaster-specific clinical conditions.

Hence the interest of having this Vade-mecum, which could be read on the way to the scene to know:

- For such situations, what will be the most common type of injuries?
- For such unusual injuries, what are the evolution kinetics?
- In front of such clinical presentations, what is the recommended procedure to follow in disasters?
- With such injuries and urgent situations, what are the inappropriate clinical acts?

This Vade-mecum is needed since it contains valuable experience collected throughout the work of a medical team who faced similar situations in terms of the nature and severity of injuries, and the outstanding number of patients. Can it contribute to the dissemination of knowledge that is validated nowadays, and to save lives and to alleviate sufferings?

General-Doctor (retd) René Noto

Emeritus president and a founding member of SFMC

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- All fellow writers who gave this manual all its value by their skills and work. Highlighting at the same time their compliance and acceptance to the specific pattern of this manual, and their effort to guarantee the required harmonious style. We particularly thank our female and male colleagues who are still in activity, totally taken by COVID-19 health crisis, and yet spared us some of their valuable time to co-author this work.
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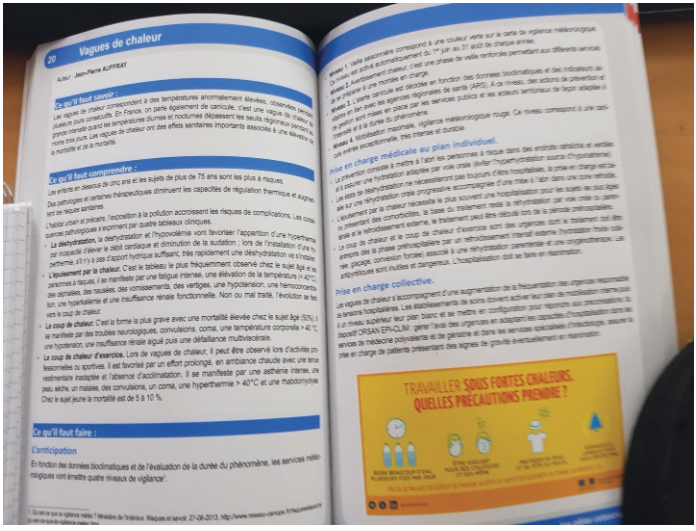
We add to this acknowledgement list the SFMC members whose loyalty and trust allowed our almost 40-year-old learned community to preserve its activity and productivity.

Eventually, we thank our readers for the trust they endowed us with hoping that this guide meets their expectations.

As well, we invite readers to send us their critics and remarks in a mail to medecine.cata@gmail.com or just post them on www.sfmc.eu.



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Abbreviations

ABC	Airways, Breathing, Circulation
AHS	Army health service[1,2]
AMP	Advanced medical post
ARF	Acute respiratory failure
AU	Absolutely urgent cases
CBRN	Chemical, Biological, Radio-Nuclear
CCP	Casualty collection point
CEP	Casualty extrication point
CIVIC	Hospital health information system
CMM	Crisis medical management unit
COPG	Command/commander of operation of police and gendarmerie
COSI	Command/commander of Special Forces' intervention operations (*COIS*)
CP	Command/commander post
CRA	Cardio-respiratory arrest
CRW	Centre of reception of walking victims
DCP	Dead victim collection point
DO	Director of operations
EDP	Evacuation dispatch point
EOC	Emergency operation commander/command (*COS*)

[1]List of abbreviations employed in this book and their *French* equivalent*s* (whenever appropriate).

[2]Side note: for the translation purposes, the French term SAMU/SMUR will be maintained all over this guide as it represents the internationally acknowledged French EMS.

ER	Emergency room
FMC	Field medical card
FRD	Fire and rescue department
FRO	Fire and rescue officer
HCU	Hospital crisis unit
ICU	Intensive care unit
LFRS	Local fire and rescue service (*SDIS*)
LIDA	Limited-impact disastrous accident (*ACEL*)
MED	Medical emergency director (*DSM*)
MMP	Mobile medical post (*PSM*)
OR	Operating room
ORSAN	Organising disaster response of health establishments
ORSEC	Organising response of civil protection
PHZ	Police hot zone
PPE	Personal protective equipment
RHA	Regional health agency (*ARS*)
RR	Respiratory rate
RU	Relatively urgent cases
SAMU	The French EMS
SFMC	*Société Française de médecine de Catastrophe*
SINUS	Standardised digital information system
SP	Sapper-firefighters (*Sapeur-pompiers*)
SPF	*Santé Publique France* (the French public health authority)
START	Simple triage and rapid treatment
UHC	Uncommon health crises (*SSE*)
WCP	Walking victim collection point

Part I

Introduction to Disaster Medicine

1 Disaster, Uncommon Health Crises, and Disaster Medicine

Henri F. Julien

1.1 What You Should Know

Disaster is defined by health professionals as the sudden and mass influx of victims. Generated by expected or unforeseen hazards, it creates a temporary chaotic situation necessitating previously anticipated management plans (planning) and adapted responses (emergency preparedness).

The influx of victims creates an imbalance between the sudden increase in healthcare requirements and the means immediately available. The nature of the physical or psychological injuries imposes the use of certain techniques inherent to disaster medicine.

Since 1983, disaster medicine has focused on treating somatic injuries, then psychological injuries, gradually covered CBRN and health risks, and eventually involved medico-social consequences and the resilience capacity of the population.

Disaster, called "*catastrophe*" in French, is also called "uncommon health crises" when it comes to health-related disasters [1].

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1.2 What You Should Understand

Both disaster and catastrophe are Greek words and mean "bad star" for the first and "overturning" for the second. Catastrophe is a large disastrous event where there is a serious need to react as soon as possible, to disrupt one's habits, and to force adjustments.

The hazards that result in mass emergency and disasters are classified into natural (physical), man-made (technological), social hazards (the latter two are regrouped under anthropogenic hazards by the WHO), and Uncommon Health Crises (UHC).

The imbalance between the suddenly accruing healthcare needs and the means available on the ground is characteristic in disasters and defines the medical situation. It was first mentioned by Raoul Fabre [2]. The sudden increase in healthcare needs is not met, temporarily or on the long term, by a symmetrical increase in resources necessary to manage the situation.

Often, the media is attracted by the geological, economical, and even financial or insurance-related consequences. Although the latter can be massive, it is the human casualty that drives doctors' attention, e.g. presence of physical or psychological injuries and the negative effect on the population health status. Since its creation, disaster medicine has dealt with humanitarian concerns, which represent one of its axes.

Disaster mitigation aims at reducing its consequences by proper preparedness [3]: training of personnel, designing response plans, updating methods and storage of materials, defining the administrative and financial resources, and preparing the population to improve their resilience.

Disaster medicine counts on having doctors treat victims on scene just like military medicine and emergency medicine in France. Disaster medicine relies on three operational cornerstones [4]:

- Technical: including triage, decontamination, antidote administration, damage control, medico-psychological support.
- Organisational: health staff are not alone on scene; they are part of a multidisciplinary emergency and healthcare chain where everyone has a well-defined role in a hierarchical plan that guarantees its efficacy.

- Logistic: on scene, health professionals can work only when their own materials are prepared, shipped, and deployed: individual backpack, special disaster batches and Mobile Medical Posts (MMP), tent-based Advanced Medical Posts (AMP), etc.

There are two types of disasters which differ from each other by their response pattern: limited-impact disastrous accidents LIDA (ACEL in French) [5] that are managed by local safety, emergency or healthcare resources; and major disasters where those means are disabled, hence the need to rely on the arrival of external operational support [6].

Disaster medicine differs from common emergency medicine by its mass casualty, appropriate techniques, and multidisciplinary approach.

It also differs from the military practice, though copied many of its techniques, by its reorientation to meet civil healthcare needs. Overall, the hazards and risks might be different (earthquakes, industrial accidents, epidemics, etc.), the targeted population has distinct demographic characteristics (children, disabled, etc.), and the engaged personnel and means are specific.

Since 1983, a special university course has been set up in France. It is taught in Aix-Marseille, Amiens, Bordeaux, Créteil, Lille, Lyon, Nancy, Paris, Pointe à Pitre, Rennes, Saint Denis de la Réunion, and Toulouse. These courses are composed of theoretical, practical, and scene simulation components and in general, they provide two diplomas: a specialty certificate for doctors and a university diploma for the other health professionals. Other available trainings include UHC management, emergencies management, training for risky situations (CBRN, ballistic, terrorism, etc.). SFMC [7] was founded in parallel to provide post-university education courses where trainees could benefit from exchange of experience, feedback, and research, which help them progress. SFMC has its own review to publish its work [8], and website to raise public awareness (www.sfmc.eu), on which there is a private section for members.

Disasters is a field where improvised work is inefficient, hence the need for a solid internationally recognised concept: disaster medicine. It greatly resembles humanitarian medicine, which has marked its practice.

1.3 What You Should Do

- Train and prepare: disaster medicine is a specialty to undertake and to be completed by regular exercising, maintenance of skills, optimal physical fitness, and updated vaccination status.
- Do not work alone: integrate a single operational and hierarchical plan to ensure efficacy and to avoid wasting exhaustible means.
- Follow safety guidelines: the intervention site is often unsafe. Actions and personal clothing must be adapted to the situation, i.e. use of personal protective equipment (PPE). An injured doctor is an additional victim.
- Maintain calmness and reasoning: disasters usually generate stress.

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Ethics, Deontology in Disasters

2

Henri F. Julien

2.1 What You Should Know

Ethics is the area where the thought determines the action that reflects human free will [1] and their responsibility, and the application of morals to a given situation. The need for help and the social disorganisation induced by disasters abolish individual ethics in favour of circumstantial group ethics [2]. However, ethical rules and their translation into rights, as described by the deontology regulations, are always applied to caregivers, doctors, nurses, and emergency workers. Community emergencies, imminent danger, and operational requirements might incur adjustment. The comments of article 1 of deontology regulations [3] have already anticipated the situation in disasters and advised to refer to the ethics of unforeseen events.

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2.2 What You Should Understand

In disasters, “singular colloquium” is rarely doable. The healthcare chain is formed of successive chained interactions of many partners within an improvised group work frame. Task attribution, anonymization, and the necessity to do rapid and frugal technical work should not end in dehumanising healthcare work nor in forgetting deontological imperatives:

- Duty of every doctor, as every citizen, is to provide help (article R4127-9);
- Respect morality and integrity (article R4127-3);
- Respect human life and dignity, even after death (article R4127-2); obligation to maintain professional skills (article R4127-11), in compliance with acquired scientific knowledge (article R4127-32);
- Uphold of confidentiality and discretion by work partners (R4127-72);
- Provide support to dying patients, the dead (R4127-38), and their families.

Imperatives difficult to apply include:

- Patient informed written (R4127-35) consent (R4127-36) that is “simple, reader-friendly, and fair” given after full explanation (R4127-33) is often impossible to get;
- Triage of mass influx performed urgently with scarce resources is a delicate task [4] (R4127-7) that favours group rather than individual triage;
- Life-saving amputations, invasive or palliative care can be decided without prior peer-to-peer discussion (R4127-69);
- Doctor autonomy (R4127-5, R4127-95) is somehow constrained within the emergency action plan under the responsibility of EOC (emergency operation commander) and medical emergency director (MED);
- Abroad, the rules are specific to the concerned country and may be incompatible with ours, should that drive us to withdraw? (R4127-47);

- Preserving victims' rights where certificates and medical files (R4127-45) are summarised in the disaster medical form or digital record.

Permanent or temporary public service workers engaged in first-aid operations are mandated to respect confidentiality [5] as well as victims' private life and image right [6].

On scene, if doctors lost all their tools and guidelines, they could count on their respect for morals as the remaining categorical imperative [7] of their good conduct, associated with the knowledge and experience [8] they share with their colleagues and/or hierarchy.

2.3 What You Should Do

General Imperatives to Retain

- Save lives, maintain health, and protect the population;
- Uphold victims' best interests, confidentiality, and medical secrets;
- Treat victims with humanity, respect, fairness, and without discrimination;
- Avoid unethical medical actions and refuse to obey orders that do not match your moral principles;
- React within the limit of your knowledge, participate in preparedness exercises for Uncommon Health Crises (UHC);
- Treat the dead with respect and give room for funeral rites and family mourning.

On the Scene

- Give visibility to your status as a doctor: gear, coat;
- Remind and enforce the ethical principles of medical practice;
- Prompt the notions of integrity, intellectual honesty, accountability, and respect for dignity, equality, diversity, and private life [9];
- Exemplary behaviour, respect, kindness, and generosity should prevail

During Uncommon Health crises and disasters a care provider is subject to ethical and deontology standards. If it happens to deviate from these regulations, then the reaction must be proportional to the imposed situation the care-provider is facing [4].

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Medico-Legal Issues

3

Benoît Vivien

3.1 What You Should Know

Identifying victims of LIDA or major disasters is important from medico-legal and medical law points of view, in particular when such events are intended or of terroristic origin. Knowing the criminal or accidental origin is an essential demand of the authorities as well as the insurance companies, families, and on a wider scale, the society and history.

In most countries, management of dead bodies, their identification, repairing body damage of victims and beneficiaries are the responsibility of police and legal authorities, with the support of legal medicine.

3.2 What You Should Understand

The initial difficulty of medical law is to determine whether the usual means are sufficient or whether the number of victims is big enough to deploy other specific procedures: national resources or perhaps pulling together national and international resources.

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INTERPOL, the international criminal police organisation, is the referent organisation to identify victims of disasters [1].

In France, the referent unit is the *Institut de Recherche Criminelle de la Gendarmerie Nationale* (IRCGN) that can respond 24/7, even in CBRN events, all over France and abroad whenever French citizens are involved.

However, only the university institutes of legal medicine have the right to perform autopsies in France and by such they help the police and the gendarmerie.

Only the medico-legal examination and the autopsy can determine the nature, cause, and the exact time of death.

The question the forensic experts, whose job is to look for culprits, are usually asked is to determine whether some victims could have been saved if the emergency teams had come faster (Mont St Odile, Bataclan, etc.).

The identification technicians and the forensic experts have to attend scenes to look for evidence even in disasters.

Removing dead bodies from the scene cannot be done if there are still survivors to rescue.

In major disasters (e.g. train or airplane accidents), the dead bodies are rarely intact.

In transport accidents, a full autopsy of the bodies of the train conductor/pilot and their crews should be done in addition to toxicological analysis.

Management and identification of mass casualties follows a stringent method [2]:

- Recover the body and associated fragments, objects, and debris;
- Collect information from the families of victims, their doctors and dentists;
- Compare ante-mortem and post-mortem data

The three most reliable techniques scientific identification of victims relies on are dactyloscopy, odontology analysis, and DNA genetic analysis. Other methods include morphological descrip-

tion and comparison with photographs (particular marks, tattoos, scars, prosthesis, etc.), and the recognition of physical evidence (encrusted jewels, personal belongings, etc.).

Doubting the outcome of a parent lost in a disaster is, for the relatives, a heavy emotional burden, hence the need for a rapid identification of all victims.

3.3 What You Should Do

- Make sure that bodies, body fragments, physical evidence of the inquiry stay intact at the disaster scene. Keeping in mind that life-saving healthcare and rescue operations are always a priority [3];
- Coordinate actions between EOC, MED, and perhaps the commander of operations of police and gendarmerie COPG;
- Label the site of recovery in case there is a need to move the body during rescue operations;
- Medically confirm death, before or after transfer to AMP;
- Gather all victim belongings, if stripping is needed. Clearly label them and firmly attach them to the victim (not separated from the body) since sometimes they are the only available evidence for identification;
- Define a temporary morgue where corpses could be gathered once the legal authorities allow it, after discussion with the EOC and MED and the person in charge of body recovery;
- Fill in a triage form, an essential document that certifies the presence of victims on the site and constitutes the first injury assessment, which when compared with the initial medical certificate, gives the victim right for compensation or other related issues;
- Establishing a list of victims at the AMP is vital. On the one hand, to enable the authorities to inform the media about the number of victims and their injuries, and on the other hand, for each patient this list proves they received medical care on the scene;

- Respect the dignity of dead bodies and the medical and professional confidentiality that applies to all responders who participate in victim recovery and identification, whether dead or alive;
- Never disclose information on the criminal or accidental nature of the causative event to anyone who is not legally entrusted.

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Doctors and Media in Disasters

4

Henri F. Julien

4.1 What You Should Know

During any disaster, communication with the media is a sensitive subject. Sharing information with the media must be approved by the competent authorities. The released information should be exact, accurate, brief, and prepared beforehand. However, the contents of information released by a member of the medical team should reflect humane reaction and empathy.

Doctors have a special influence, and journalists, just like the population, are more willing to give doctors their trust. Nonetheless, they can criticise doctors' speech.

4.2 What You Should Understand

Preliminary Rules [1]

- Avoid unprepared communication, as that is the responsibility of the authorities. Have their prior approval;
- Answering questions should not be improvised. Prepare the release, have two-three coherent ideas on your index cards;

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- Anticipate journalists' questions e.g. How many victims? What happened? What are your actions? Are there any risks? When will the situation be under control? Who is in charge?;
- Rules not to violate: never lie, never invent. Say "I don't know" or "I can't say more for the moment";
- Keep to your area of expertise. Do not deviate to the origin of the accident, how the crisis is managed, or the possible responsibilities;
- Avoid reading (from a paper), and maintain a spontaneous and direct tone;
- Limit your answer to the question in hand;
- Take into account the emotions triggered by the event;
- If possible, support your speech with solid, real-life examples.

Specific Rules for Doctors and Health Staff

Respect medical ethics and professional secrecy.

Respect medical deontology: relationship with colleagues of other medical teams, paramedics.

Avoid giving "final" reports as the situation is susceptible to evolve with time.

Image Rights

Before public or private dissemination of photographs or footages made by the media or others, the approval of the concerned people, who have the right to object to the use of their image [2], which is part of their private life, must be obtained.

Illegal screenshots of images and videos of people as well as unconsented use of their images are subject to penalty.

The greatest caution will be required and the use of such data will be limited to educational purposes after masking the identity.

Social Media

Social Media like Twitter, Facebook, LinkedIn, etc., joined to the easiness of capturing sounds and images, offer a great, almost real-time communication means that reaches the whole planet.

Misusing them can lead to misinforming people, propagation of fake news, losing trust in authorities, which provokes anxious feeling of insecurity.

4.3 What You Should Do

Obtain Approval to Communicate
Emergency communication is the responsibility of the directors of operations (DO), EOC, criminal police operations, etc. A communication officer is usually nominated and assigned.

Adjust the Communication Method [3]
The talk should be simple, direct, and not fast.

Avoid professional or medical jargon. Do not use abbreviations or acronyms.

If you have no answer, do not get swept away, say "I don't know", "it is too early to say", "there are many hypotheses", "investigation is in progress".

Avoid controversy or getting into conflicts. Stick to your role as expert.

Monitor non-verbal language: avoid being rigid, or seriously agitated. Maintain a natural talk pattern without straining your voice.

Special Cases
- **Written press**: the interviews are recorded.
  Answer the questions with accuracy without digression. If possible, have a look at the text before it is published.
- **Radio**: in general a news story lasts less than 1 min which gives the room for two options:
  - Recorded interview: it is possible to retrieve here. Be careful of "off-the-record" talk, which is interesting for many.
  - Direct interview: use short sentences and simple wordings.

  After the interview, it is always possible to underline some points you judge important to appear in the written press or to be mentioned by the journalist in the radio news.
- **Television**:
  A TV news story is shorter than that of radio.
  On-scene interviews: ask a third person to check your dress and look (tie, shirt collar, etc.); in studio, expect some make-up.
  Look at the interviewer rather than the camera.

Always use short sentences and simple wording.

– If the TV show is direct:
  - The time allocated for it is so short, so get to the essential points;
  - Carefully listen to the question and understand it, ask for repetition if need be;
  - Avoid negatively interpretable movements or signs e.g. showing the finger;
  - Wait for the show to end to stand up.
– If the show is recorded:
  - It is possible to retrieve (re-record);
  - Show editors will only keep few clips of the interview.

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Part II

Organising Healthcare and Emergency Actions

ORSEC-NOVI Plan

5

Francis Huot-Marchand

5.1 What You Should Know

Novi (numerous victims) [1] plan, former (French) Red Plan, is an emergency plan elaborated as part of ORSEC (organising response of civil protection) [2, 3] preparedness plan. Novi is activated in accidents involving a big number of victims in one site. Once activated by the prefect, as the operations director (DO), all the emergency chain responders are called to move [4].

The objectives of implementing NOVI are:

- Containing the initial disaster and extracting victims out of danger;
- Providing first aid and preparing victim evacuation to hospitals

This generic plan is adaptable to diverse situations such as terroristic shooting with hostages taking, multiple attacks, and use of chemical warfare agents.

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5.2 What You Should Understand

NOVI plan is deployed in limited-impact disastrous accidents (LIDA) [5], community emergencies, or disasters to optimise the capacity of the police (safety), rescue (Sappers-firefighters), health (SMUR and SAMU) responders, as well as related relief organisations*.

One site, one mission, and one commander are what characterise the response of this general plan facing the initial chaotic situation, and should be adjusted by MED following a precise operational flowchart. This multidisciplinary preparedness scheme has already proved its effectiveness. The plan objectives are achieved upon fulfilling its functionality requirements:

- Providing sufficient and adapted resources rapidly
- Coordinating the supply and attributions of these resources

The rational management of the command chain ensures its good functioning (Fig. 5.1)

Under the command of EOC, two emergency chains work jointly (Fig. 5.2):

- Fire—rescue chain: combat the initial event, search, localisation and release of victims, and life-saving measures performed by the rescue team;

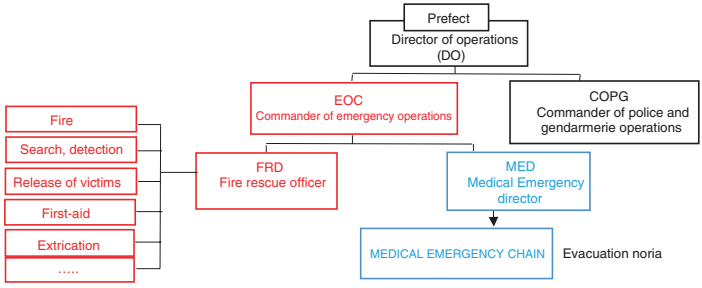

Fig. 5.1 Command chain. General scheme

*vSAMU-SMUR = the French EMS

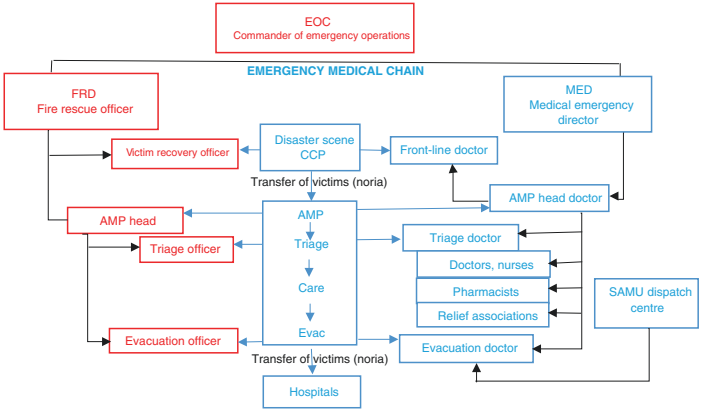

Fig. 5.2 Emergency chains scheme

- Pre-hospital medical emergency chain, which divides its work into three axes:
  - On scene recovery: life-saving measures conducted by medical responders, with medication as appropriate, victim recovery and transport (noria) to CCP, AMP, and primary triage by responders;
  - Medical triage at the entry of AMP, treat and prepare for evacuation;
  - Evacuation of victims to hospital as recommended by the dispatch centre.

In addition to reception and medico-psychological support of victims, sometimes management of morgue is undertaken.

5.3 What You Should Do

- Identify community emergencies (LIDA) and alert SAMU and the local fire and rescue service (LFRS), and follow instructions of EOC, the first LFRS officer on scene;
- If first doctor on scene, refrain from therapies that benefit only one victim; perform site reconnaissance, establish a primary

report (characteristics of LIDA, estimated number of victims, need for backup, site access, and a meeting point, etc.), and send it to SAMU/LFRS;
- MED, jointly with EOC, ensure the management of medical emergency operations in terms of assigning responsibilities and identifying the location of operational points i.e. AMP, vehicles gathering point, landing zones for helicopters, etc.;
- Learn about NOVI (response) plan and practise regularly in exercises with other first responders teams.

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6 Hospital Disaster Management Plan: Uncommon Health Crises (UHC)

Jean-Pierre Auffray

6.1 What You Should Know

Organising disaster response of health establishments (ORSAN) to face UHC, as well as external or internal threats to the health facilities, is a legal obligation. In 2014, ORSAN response plan was set-up by a ministerial directive [1]. In 2019, new guidelines for preparedness and management of hospital pressure and UHC was published [2].

6.2 What You Should Understand

Hospitals are exposed to certain threats and those related to external events generate a distracting influx of patients that surpasses the management capacity of the hospital, which has, in the same time, to maintain the existing inpatient, outpatient, and other daily emergency care work.

Risks and threats induced by internal events or structural failure could lead to hospital evacuation or lockdown.

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ORSAN plan helps the health system improve its response to UHC. This concerns the events where the health system can lean on its available health resources to manage it, within the objective to optimise means and workforce and to take all necessary measures to absorb the increased work burden.

ORSAN is composed of five components: ORSAN AMAVI concerns influx of non-contaminated victims; ORSAN CLIM concerns management of mass influx of victims of climatic disasters; ORSAN EPI-VAC to manage an epidemic or pandemic in the country, and could include organising vaccination campaigns for the purpose; ORSAN REB to manage a known or emerging biological risk; and ORSAN NRC to mitigate CRN risks.

6.3 What You Should Do

Prepare and Anticipate

Preparedness response plans for UHC and internal threats and crises should follow the most recent guideline directives.

- The health establishment director relies on a team composed of a crisis medical manager (CMM), who acts as the project manager, and the hospital referent consultants.
- Elaborating an effective preparedness plan takes into account the analysis of risks and threats, assessment of hospital response capacity, identifying available resources (staff and equipment), and determining the outcomes to obtain from the objectives set by the Regional Health Agency (RHA) within ORSAN.
- A well-conceived preparedness plan should ensure an effective response: upscaling reception capacity, reorganising patient flow, adaptable workforce and staff lists, cancelling health procedures and freeing up beds, supply of additional material resources, evacuation, lockdown, and maintaining security.
- The establishment should implement a policy to inform its staff about the disaster preparedness plan to mitigate crises. Field exercises are a good opportunity to assess the effectiveness of the plan and its procedures.

Activate the Plan and Lead It

The contingency plan (*Plan Blanc* in French) is activated by the establishment director or at the request of the supervising authorities. The activation can go gradual and upgraded at two levels:

- **Level 1**

  Internal response plan: activated in case of pressure on hospitals or potentially critical situations that do not jeopardise on the short term the hospital every day work. Nonetheless, this type of situation is critical enough to implement special procedures, active vigilance, and if appropriate, initiate anticipation or management measures.

  This level requires the activation of the hospital internal response plan, which includes the set-up of a limited hospital crisis unit (HCU).

  This level also includes preparedness to risks that could threaten the hospital and necessitate pre-alerting, activation of HCU, and mobilisation of the concerned services.
- **Level 2**

  Disaster management plan: activated in case of uncommon situations with a potentially major impact on hospital. This level mobilises all hospital capacities as part of a special management plan led by HCU where information is centralised, tactics are decided, and instructions are given accordingly.

  The plan missions are to analyse the situation, coordinate response actions, and decide the response to take and the means to apply it.

In case of mass influx of patients, the operational medical management of the emergency department and of the medico-surgical technical platform is put under the responsibility of a previously assigned and trained doctor, who undertakes the role of the Crisis Medical Manager (CMM)[1].

[1] See Chap. 10.

End of Crisis and Feedback

Once the situation is stabilised, the hospital director in agreement with the Regional Health Agency and after exchange with SAMU, terminates the contingency plan. Hospital should resume its daily work progressively. Retrospective analysis of the conducted actions and their consequences should be systematically performed after the crisis.

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Emergency Chain in Disaster Medicine

7

Stéphane Travers

7.1 What You Should Know

Managing disasters casualty necessitates joint action of multiple first responders coming from services or organisations that have complementary skills.

The overall management can be described as a chain whose effectiveness will depend on the actions conducted by every component, the responders' shared awareness of the situation, and the coherence of their complementary work [1, 2].

This chain includes classical steps such as victim recovery, triage, medical care, then evacuation towards hospitals, and other steps that are modifiable according to the situation in hands.

Limited-Impact Disastrous Accident (LIDA) (Fig. 7.1)

Major or Multisite Disasters (Fig. 7.2)

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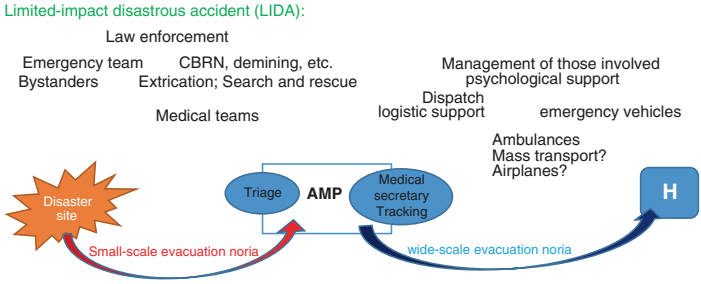

Fig. 7.1 Emergency chain in LIDA

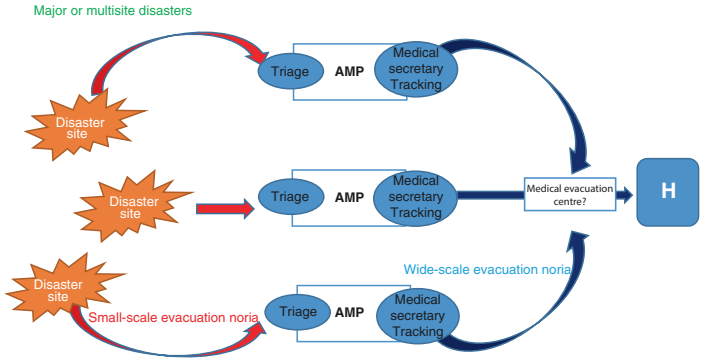

Fig. 7.2 Emergency chain in major or multisite disasters

7.2 What You Should Understand

The overall objective is to reduce preventable mortality of the most seriously injured whilst maintaining high quality care for all involved people.

For such, all emergency chain responders should:

- Be part of a general coherent, hierarchical, prepared team following the orders of the commander of emergency operations (EOC), and for the health team, the orders of the MED;
- Be able to cope individually or as a team with the real situation on scene, despite uncertainty and sometimes danger, which

implies having common objectives, effective inter-services preparedness, and trustful relationship between responders as of daily work.

Depending on their abilities, all health staff should integrate the emergency chain or its complementary health care programme, after informing the operational authorities on scene (MED).

7.3 What You Should Do

For First Responders

- Begin the actions that are specific to your team: put threats (fire, shooting) under control, provide first-aid care, extricate and gather victims, etc.;
- Contact the heads of the partners services (police, firefighter, medical teams, etc.), and jointly define common strategies, objectives and actions;
- Inform your own leader, ask for support, etc.

For the First EOC and the First Medical Team on Scene

- Do the work of the first EOC and the first MED till the arrival of the officially assigned personnel;
- Start implementing the emergency chain.

Staff of the Medical and Emergency Teams

- Present yourself to EOC or to MED and identify your role in the plan;
- Provide care to victims;
- Show resilient attitude in such specific situations, help maintain the fluidity and the fast run of the care chain and evacuation;
- Report on the encountered difficulties.

For EOC, MED, COPG, and Every Leader

- Organise and manage response according to your field of work, adapt the plan to the specific situation in hands;

- Attribute resources to the staff under your command and provide them with information that helps them understand and adjust their actions accordingly;
- Interact with the leaders of the other services;
- Report to your own superiors

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Medical Emergency Director (MED)

8

Henri F. Julien

8.1 What You Should Know

The doctor, whether permanent or assigned director of medical emergency, is in charge of deployment and functioning of the emergency chain and emergency care in community emergencies or uncommon events [1]. Working under the responsibility of the emergency operations commander within ORSEC-NOVI [2] plan, and after analysing the situation, MED should ask for and manage the required staff and resources according to a state of concept articulated with ORSAN AMAVI [3].

8.2 What You Should Understand

The director of medical emergency has to follow a special training to acquire the related knowledge, skills, and attitude. It is a difficult assignment based on a defined state of concept and made possible by the expertise of the undertaker. The first doctor on scene, pre-MED, kicks-off the plan.

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Preparedness is the rule; prepare plan B to use in case of difficulties or dangerous evolution of the event.

8.3 What You Should Do

Undertaking Responsibilities

At the beginning and on the way to the scene, collect all possible information and announce your arrival. Contact EOC or COPG, and the first responding doctor. Don your MED uniform and maintain a radio contact with EOC.

Perform rapid site reconnaissance: nature and evolution of risks, estimated number and condition of victims, available means.

Request application of NOVI plan or confirm it, define your action plan as advised by EOC.

Send a primary report to inform the headquarters and to ask for resources needed on scene, and indicate the time and the meeting point to receive them.

Remind all to follow the safety procedures.

Attribute operational responsibilities and give clear indications:

- Set the location of AMP according to security, access, ergonomic, and vicinity criteria after deliberation with EOC;
- Assign key roles to responders who should don their uniforms:
  - For victim recovery and small-scale stretcher-based evacuation noria, generally a sapper-firefighter (SP) officer is in charge. Provide necessary staff and materials, and if need be, medical care during recovery, remind all of rescue triage rules.
  - For AMP, the role is shared between the head doctor of AMP in charge of medical triage and medicating absolutely and relatively urgent cases, and the AMP officer in charge of logistics in terms of deploying necessary means, management of stretcher holders and procurement staff. Both should ensure good tracking by systematically creating paper and/or digital triage records.

  - For victim evacuation, generally an SP officer is in charge of gathering and counting evacuation vehicles, maintaining drivers in their vehicles, and preparing the evacuation.

Establish a tactical radio network with transmission means managers and deploy, whenever needed, a command centre for MED next to the command centre of EOC.

Contact the representatives of the concerned services and the emergency or ambulance crews, in particular:

- The on scene SAMU dispatch doctor with whom the concept is shared. The latter organises with SAMU the dispatch destination of victims.
- The managers of the emergency and ambulance teams you integrated into the network.

Regularly re-evaluate the situation to communicate to EOC, to SAMU, and to the engaged operational managers. Post it at the command centre of MED.

In case of persistent or evolving risks where cordoning is imposed (chemical, ballistics, hostage taking, fire in buildings open to public, search and rescue, etc.), respect the zones limits and assess, with EOC, the interest of medicating victims in the hot zone.

Seek, if applicable, the deployment of special resources for victim recovery, treatment, or evacuation (e.g. by helicopters).

Care to have those involved assembled in a safe area where they can benefit from medico-psycho-social support and organised reception.

Set-up a temporary morgue, even though corpses management is the responsibility of legal authorities.

In major disasters, manage scene emergency operations, if comes to deal with, similarly.

Work Progress, Make Sure of

- Fast evacuation, particularly of extremely urgent cases that can bypass AMP if the medical teams are deemed sufficient in number. Give priority to the most critical cases;
- Upscale of efforts, however, AMP installation should not delay recovery-care-evacuation process;

- The quality of undertaken emergency and care measures, as well as the adequate management of cases according to their severity;
- Perfect alignment between ORSEC NOVI and ORSAN AMAVI;
- Appropriate material and logistic supplies;
- Regular update of information sent to the authorities, via EOC, or directly if the latter requested it, provide step-by-step reports and updates of the operational situation (*SITAC* in French);
- Listing by the command centre of MED of victims who entered this chain;
- The efficient contact between the diverse responding services, and organise their joint work;
- If necessary, organise responders' shifts.

At the End of the Intervention

- After evacuating the last injured or involved victims, report to EOC and request the termination of the plan. Call for a general meeting of all the participating organisations and services. Compile a formal list of victims. Encourage exchange on the course of the intervention;
- Write a personal statement, which will potentially serve as a basis for a report;
- In agreement with the EOC, participate in the media communication sessions.

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First Doctor on Disaster Scene

9

Henri F. Julien and Bertrand Prunet

9.1 What You Should Know

Two possible situations to be the first: being a bystander or a victim of a community emergency, and being in the first medical vehicle arriving at scene. Collect and transmit operational information [1] urgently to take care of and save as many victims as possible [2]. At the initial phase, refrain from any therapeutic procedure; rather analyse, direct, advise, and inform.

9.2 What You Should Understand

Emergency teams of SP and SAMU doctors are the first to respond. The first doctor must opt for rapid and appropriate scaling up of services work. First, provide no medical care, and proceed with the most effective attitude that serves most. Those are necessary deontological adjustments approved by the Medical Council [3] for disasters and UHC.

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Immediately contact the commander of the EOC and follow the instructions of the latter.

9.3 What You Should Do

A health staff being a bystander or a victim, alert public services [4]:

- Keep calmness, analysis capacity, and own medical position;
- Stay safe since an injured doctor is compromised [5];
- Prevent secondary accidents;
- Once sure of the seriousness of the situation, locate your position (smartphone), call (18, 15, 112[1]) as follows:
  - Present yourself: *Dr. X, serious accident with probably many victims*;
  - Locate the position: *the event is located at* …….: address or a landmark;
  - Probable nature, estimated seriousness;
  - Indicate that your primary evaluation will be detailed in a circumstantial report;
  - Never hang on before permission.
- Keep yourself safe and move towards the accident site with your smartphone.

Two imperatives: stay safe and urgently provide the authorities with the most reliable information.

Reconnaissance, Circumstantial Reporting
It is the first professional assessment [6]. On your way to the scene, collect as much information as you can (telephone, GPS, Google Earth, etc.).

- On the scene, make a rapid tour around to:

[1]Emergency numbers in France: 15 for French EMS (SAMU), 18 for SP (France), 112 for emergencies in EU countries.

  - Recognise the nature of the event, its potential evolution (pending danger?);
  - Estimate the number of casualty, nature and severity of injuries:
    Absolutely or relatively urgent,
    Dead,
    Involved/walking;
  - Refrain from any therapeutic procedure, ask other bystanders to do it;
  - Do not accept unorganised evacuations;
- Contact the emergency centres and send a circumstantial report:
  - I am at (address);
  - I see (nature of the disaster);
  - I did (first performed measures);
  - I ask for (support/resources);
  - Give details on:
  - The nature of the event and its possible evolution;
  - Victims' number, nature and severity of their injuries, and if there are children, disabled, etc.;
  - Available means, ongoing emergency and care operations;
  - Performed actions;
  - If possible, itinerary to the scene and a collection site.
- Do not hang on, wait for instructions from 112, 15 or 18:
  - Need to activate NOVI plan, others? Helipad? Weather and brightness level?;
  - Your phone number for possible call back.

This report will allow emergency centres to adjust the convoyed resources according to the needs as assessed by a professional.

Technical Measures
Those performed with no materials, simple and effective:

Individual measures:
- Pull victims away from serious and imminent dangers [7];

- Stop haemorrhage [8]: with manual compression and compressive dressing, apply tourniquet immediately; remove it, if necessary, whilst monitoring haemodynamic status;
- Free the upper airway passages: tilt the head back, laterally position the body, remove obstructing foreign bodies;
- Rinse with plenty of water caustic splashes;
- Put victim in recovery position according to injury site, as follows:
  - Abdominal: in supine position with legs bent;
  - Chest injury or breathing difficulty: 45° inclined;
  - Limbs: if upper, immobilise it by a sling, if lower, tie it to the intact side.
- Show empathy and reassurance via verbal contact with the victim and the surrounding.

Group measures:

In certain situations: bad weather, long isolation and after contacting 15, 18, or 112:

- Set a CCP or an AMP in compliance with safety (immediate and indirect), site accessibility, ergonomic, and vicinity conditions;
- Document triage details and warrant victim tracking.

As soon as possible, get into contact with the first commander of EOC, with MED, to provide operational information and to join the deployed emergency teams.

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Role of the Medical Manager of Intra-Hospital Crisis

10

Matthieu Langlois and Mathieu Raux

10.1 What You Should Know

In uncommon health crises (UHC), hospitals organise themselves to manage the crisis in coordination with the emergency services. They have their crisis unit to select which care strategy to use facing the influx of patients and injured victims.

Given that even in UHC the hospital has to provide the best healthcare services, the objective is to avoid reaching saturation and breaking point, which means higher mortality.

The crisis medical manager (CMM) is a doctor whose job is to consolidate preparedness of the hospital directory board thanks to two skills [1, 2], namely:

- Medical knowledge of healthcare structure, procedures and resources;
- Crisis management and sense of leadership.

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10.2 What You Should Understand

The CMM works under the authority of the hospital directory board and acts as the hospital MED similar to that of the emergency teams.

The CMM puts medical expertise at the service of the hospital crisis unit.

The CMM helps take strategic decisions.

The CMM adjusts the hospital response to match the flow of patients. Upstream, the CMM is in close contact with the emergency teams and the dispatch centre, and downstream coordinates with the regional health agency (RHA) to facilitate patients flow to other public and private health structures.

As shown in Fig. 10.1, the CMM can count on the hospital crisis unit (HCU) for help e.g. to analyse pitfalls and to look for innovations [3].

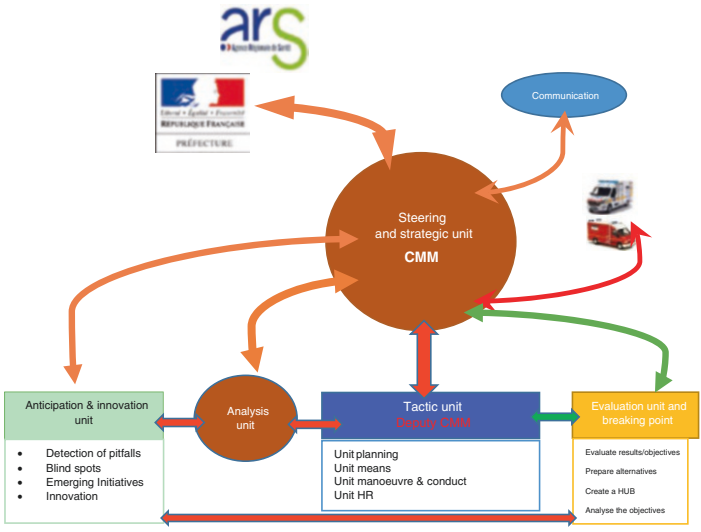

Fig. 10.1 Crisis medical management unit (CMM) and hospital crisis unit (HCU). *ARS* (French): Regional health agency. (With Courtesy of M. Langlois)

10.3 What You Should Do

- The CMM is taught and trained to manage crises;
- once a UHC is detected, the CMM quits routine clinical work to focus all efforts on crisis management;
- Coordinates work of the different HCUs;
- Makes him/herself known to pre-hospital decision-makers (SAMU-SDIS[1]) for whom the CMM becomes the correspondent;
- Guarantees the strategic consistency of hospital healthcare work;
- Organises regular updates of the situation;
- Continuously adjusts the strategy of action after discussion with SAMU and RHA;
- Maintains patient flow within the objectives to avoid reaching the breaking point;
- Prepares the post-crisis step and request feedbacks.

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[1] SDIS (French): Local fire and rescue service.

Triage of Disaster Medicine

11

Henri F. Julien and Bertrand Prunet

11.1 What You Should Know

Triage, originated in military medicine, has been adapted to face civil community emergencies. Given the impossibility to treat all immediately (mismatch between means and needs, shortage of resources), it is vital to treat the most serious cases first: general interest prevails over individual [1] interest. Triage was originally practised at the entrance of the AMP, nowadays it is sequentially applied from the moment of victim recovery till hospital. However, it is adaptable and can be readjusted to fit the clinical evolution, type of injuries, and hospital capacity. Paper or digital records of the triage are necessary to ensure traceability and visibility.

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11.2 What You Should Understand

What Are the Four Goals of Triage [2]**?**

- Set treatment priority: spot and immediately treat cases for which medical care is paramount and/or cases for which the treatment cannot be put off;
- Form homogenous groups of victims: to optimise the efficiency of the small-number team; ER[1] doctors and surgeons manage the most critical cases, other members provide basic healthcare;
- Manage patient flow: evacuation should be reasoned and timed by the dispatch centre to meet the Golden Hour window and to prepare hospital reception;
- Maintain life-saving measures conjunct: diagnosis should be followed by necessary relief or care measures according to the triage officer's skills.

What Characteristics to Consider in Triage?

- Seriousness of clinical status:
  Classified into two categories: immediate or potential life-threatening risk and no critical condition (consciousness and ABC = Airways, Breathing, Circulation and their evolution).
- Specialty of triage-performing doctor:
  As advised by surgeons, ER doctors perform triage. Psychiatrists, paediatricians, burn specialists have already set their criteria. On scene, emergency services and paramedics perform simplified triage.
- Emergency and healthcare method of action:
  The method differs whether it is a battlefield (dealt with by NATO: role 1, 2, and 3) or a civil disaster (dealt with by SAMU); according to the evacuation time and the capacity of the technical platform of the receiving facility; the triage is adjusted in case of decontamination, long or complex surgical operations.

[1] ER = emergency room.

What Are the Selected Systems?

Classical triage performed by an experienced doctor:

Four categories classified under two families are selected following the physical status, prognosis, and the evacuation method (see Table 11.1).

Table 11.1 Triage for evacuation

	Category	lesion type	Evacuation
Absolutely Urgent	**Extremely urgent (EU)**	Immediate life- threatening condition • Cardio-circulatory failure (poly-trauma, crush syndrome, etc.) • Severe uncontrollable haemorrhage (abdominal, vascular, non-tourniquetable, etc.) • Asphyxia (chest trauma, cervico-maxillo-facial trauma) • Head trauma with focal deficit/unequal pupils • Burns >50%	Priority after effective resuscitation
	1st degree emergency (U1) **Delayed up to 6h**	Critical victims threatened by failure of a vital organ (shock, respiratory distress, neurological failure or sepsis) • Chest or non-asphyxiating gas injury • Compressible vascular injuries • Head trauma with no focal deficit • Open fractures and osteo-articular wounds • Compression syndrome • Deep burns between 15– 50% • Hypothermia < 22°C	Rapid to the closest hospital after proper stabilisation, by road or helicopter
	Physical emergencies (PE)	Lesions characterised by their pattern (eye, face, hand), non-life threatening, with possible functional or aesthetic impact. • Penetrating eye injury • Debilitating trauma of the distal parts • Circular burns of limbs, hand • Maxillo-facial trauma	Rapid to the closest hospital, to the corresponding specialised departments after proper stabilisation, transport by road or helicopter, with U1 whenever possible
	Potentially urgent (PU)	Lesions likely to worsen either unexpectedly or due to transport. • Cranio-encephalic trauma • Chest or abdominal trauma • Suspected blast lung or blast abdomen • Burying injuries (under rubbles)	To hospitals; timing depends on the number of victims and the available evacuation means
Relatively urgent	**2nd degree emergencies (U2)** **Time limit = 18h**	Non severe cases for whom surgeries can be performed within 12–24h • Closed fractures • Soft tissue injuries (except buttocks and perineum) • Mild head trauma (conscious) • Burn <15% • Inhalation poisoning with absence of respiratory or neurological symptoms	Less urgent, towards more distant hospitals, by air, train, or road transport
	3rd degree emergencies (U3) **Time limit = 36h**	Mild injuries not likely to evolve, possible to delay evacuation for >18h and in non-medical vehicles. • Mild trauma (sprain, bruises) • Small contained wounds • Superficial burns < 15% • Ambulant and walking victims	Non urgent transport in non-medical vehicles, whenever possible
	Beyond help (D)	Severe injuries that cannot be treated immediately andare hopeless	No evacuation Provide support to families

- **Extremely urgent—E.U: Life-threatening requiring immediate treatment**: medical transport to operating room with resuscitation.
- **U.1: Life-threatening due to rapid irreversible deterioration**: surgery within 6 h after effective resuscitation. Medical transport is required.

Those two categories are classified as **absolutely urgent**, and tagged Red , Priority 1/Immediate.

- **U.2: Not immediately life-threatening, delayed care up to 18 h**: seriously injured needing hospitalisation, evacuation by medical ambulance or not e.g. closed fractures of long bones, soft tissue injuries, mild head trauma (conscious), etc.
- **U.3: Delayed care up to 36 h**: mild injuries with basic care, transport in ambulance if possible

U. 2 and 3 are classified as **relatively urgent**, and tagged yellow as Priority 2/Delayed.

Green : Minimal/non-urgent is attributed to involved victims who may need some care and eventually psychological follow up.

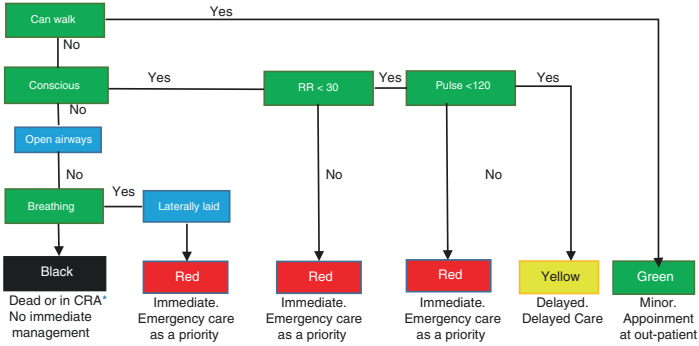
This table is generally completed by:

- Physical emergencies: eye, hand, face and mandible are classified Red ;
- Potential emergencies: blast lung, crush syndrome, poisoning, etc. are classified yellow with observation.

Primary triage performed by a doctor:

Called Simple Triage And Rapid Treatment (START), adapted and generalised by NATO and WHO, it defines based on simple clinical data categories of victims on which it assigns a colour and a course of action (see Table 11.2). It is completed by first aid measures i.e. control of bleeding, prevention of hypothermia, dry decontamination, etc. START is a primary triage used by civil pre-hospital teams.

Table 11.2 START algorithm



[a]CRA: Cardio-respiratory arrest

Specialised triage methods:

- **NATO triage for war casualty**:
  Suitable for low-intensity conflicts and relies on rapid evacuation as part of military medicine practice and evacuation (role 1, 2, and 3). It counts on two criteria to sort out casualty: physical signs and type of care (ICU, surgery). The distinguished stages are:
  - **Absolutely urgent** classified as α or T1/Immediate;
  - **Relatively urgent** classified as β or T2/Delayed;
  - Minimal injuries or ambulant victims classified as T3/Minimal;
  - Severely injured with very limited chance to survive: beyond help, T4/expectant.
- **Triage of burns:**
  Burn specialists have their own triage method for burns of second or third degrees
  - >50% burn: extreme emergency, Red ;
  - Between 15% and 50% burn: first degree emergency, Red ;
  - Less than 15% burn: second degree emergency, yellow .

  Burns involving airways, flexion zones, face and neck are taken into account.
- **Triage performed in psychiatry**

Every person who is dangerous to himself or to the others is first degree emergency, Red .

11.3 What You Should Do

Follow routine work [3]:

Take Present History with Complete Past History, Physical Examination (ABC):

- **Nervous system/Airways**, if consciousness is affected, check GCS (Glasgow Coma Scale), look for focal signs;
- **Breathing**: respiratory rate, cyanosis, indrawing, chest asymmetry;
- **Circulation**: heart rate, pulse, peripheral pulses, capillary refill, shock signs (malaise, pallor and sweating, rapid weak pulse, peripheral cyanosis).

Careful Inspection to Look for Lesions in

- Skin, skull, scalp;
- Neck, loins, chest, abdomen, pelvis;
- Limbs and joints
- Eyes, hands

Wound Dressings Should Not Be Stripped, If Necessary, Temporarily Expose the Wound and Put Dressing Back Rapidly

- Sorting out a victim takes 30–60 s without interrupting care nor evacuation
- Avoid over-triage or under-triage, which are ineffective.

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12 Advanced Medical Posts (AMP)

Stéphane Travers

12.1 What You Should Know

The advanced medical post (AMP) is a place to assemble and treat disaster casualty. Initially was called "Triage and care centre".

Its location should ensure:

- Safety since any further relocation of the AMP will be potentially difficult and harmful to the patients;
- Accessibility to allow easy stretcher transfer from the front lines then rapid evacuation to hospitals;
- Ergonomics to ideally give healthcare staff proper space to work (e.g. lighting), and to protect patients (cold, bad weather, etc.);
- Being close to the collection point (in compliance with safety guidelines).

Each event has its unique AMP in order to help manage flow of patients. For such and depending on the scale and/or type of the

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disaster (earthquake, multi-site attack, big fire, etc.), sometimes it is necessary to set up several AMPs.

Each AMP has its own head doctor to run it, who in turn follows the orders of the medical emergency director.

12.2 What You Should Understand

In disasters, the number of victims often exceeds (temporarily or longer) the immediately available resources. **Assembling the casualty optimises the response of the emergency teams** [1, 2].

The first collection point is often called **Casualty Collection point** (CCP). AMP is a place staffed by prehospital medical teams and provided with the logistic equipment required to treat victims (Fig. 12.1).

AMP should have:

- A unique entrance through which victims are triaged into Absolutely Urgent (AU) or Relatively Urgent (RU);
- Two distinct zones to receive AU and RU casualty;
- A unique exit where there is a medical secretary and a medical dispatch officer to ensure tracking of evacuated casualty.

AMP is a "concept" adaptable to the nature of injuries and to the environmental conditions [3]**:**

- A cafe, a restaurant, a quay, a station hall, or even a gym (which has, if possible, two doors for entrance and exit), are good locations for AMP in cities;

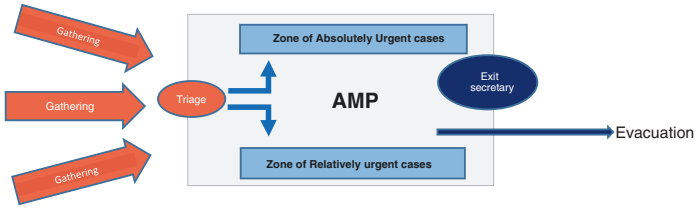

Fig. 12.1 The role of AMP inside the emergency chain

- The hall of a building or simply a cordoned open-air zone can suffice to sort out and rapidly evacuate the injured;
- Any mobile unit (tents or others) can be useful in bad weather or at night, if no other infrastructure is immediately free for use on scene, and provided that the units are rapidly deployed to avoid delaying the evacuation of urgent cases [4].

Two Pitfalls Must Absolutely Be Anticipated

- **Only critical victims requiring medical care must be managed at AMP**. Involved/non-injured people should be gathered and managed in a separate nearby area (walking-victims' collection point WCP).
- **Setting up an AMP should never delay victim evacuation**. Any AU (especially bleedings) should be immediately evacuated to the operating room (way before the golden hour, if possible). Depending on the situation, such injuries can receive life-saving measures at the AMP or be immediately transported by medical vehicles without passing through the AMP [the AMP medical secretary should document the patient's name (or number at least), and destination].

12.3 What You Should Do

- First emergency teams: gather the victims in a safe place, identify AU and RU, and initiate first aid.
- First medical team: approve the location of AMP, organise its functions and start life-saving interventions and medical care, establish a single list of victims, attribute missions to the emergency and medical teams when they are on scene (gathering, care at AMP, evacuation, etc.).
- Doctors and nurses assigned to work at AMP: provide care to one or several patients of AU or RU zones. Adjust time, procedures, and resources in a way to optimise care and chances of survival of as many victims as possible. Compile for every patient a field medical card. Transmit to the AMP head doctor and/or the dispatch centre doctor the information that can help

them select the appropriate destination. Ensure fast evacuation of casualties.

- Medical emergency director (MED): confirm or assign the AMP head doctor, provide the latter with necessary resources (emergency teams, medical teams, logistics and communication means, etc.), supervise AMP functioning and ensure that norias of collection and evacuation (particularly of severe cases) are fluid and fast. Report to and ask the EOC commander and the other concerned authorities (crisis unit, dispatch centre, etc.) for additional resources.
- AMP head doctor: organise tagging at the AMP entrance, task staff to work at AU or RU zones (depending on their skills). Monitor the quality of care, and ensure rapid allocation of destinations and tracking of evacuated victims (single list) by the medical secretary at AMP exit. Upstream, maintain a permanent contact with the assembling officer and the AMP officer inside AMP, and downstream with the evacuation officer and the dispatch doctor. Ask MED for additional resources and provide updated reports throughout the entire operation.
- Dispatch doctor: decide to which hospital every victim is evacuated (individually or in a group). Ensure that the evacuation is not delayed because of unavailability of hospital places.

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Casualty Collection Point (CCP)

13

Henri F. Julien, Bertrand Prunet, and Benoît Vivien

13.1 What You Should Know

Casualty collection point (CCP), situated in the hot zone or at its boundaries, is the site where the most seriously affected, poisoned, or wounded victims are immediately managed, rescued and probably receive care, even before entering the medical chain: Triage- AMP- evacuation. Its concept was initially conceived to contain the impact of terroristic attacks with chemical warfare agents (by administering antidotes) even before entering the decontamination chain [1].

Later on, facing the ballistic attacks with hostage taking, which required fast management of bleedings, the concept of CCP installed at the periphery of exclusion/hot zone, at the end of its evacuation tunnel, was applied [2].

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It is a matter of providing extremely urgent care (antidotes, damage control), which does not preclude the rules of primary triage and traceability. Ideally, only extremely urgent victims (EU) can benefit from such a short circuit that bypasses AMP to have earlier surgical intervention.

13.2 What You Should Understand

Deciding to set up a CCP is the responsibility of the person in charge of organising and deploying emergency operations. The location, functions, and situation of CCP inside the medical emergency chain should be rationalised (Fig. 13.1).

In case of a chemical attack, CCP constitutes a transition area between the hot and the warm zones.

It is installed on the premise of rapidly detecting and treating the most critical cases. All first responders must don their PPE (personal protective equipment), including doctors, nurses, and/or

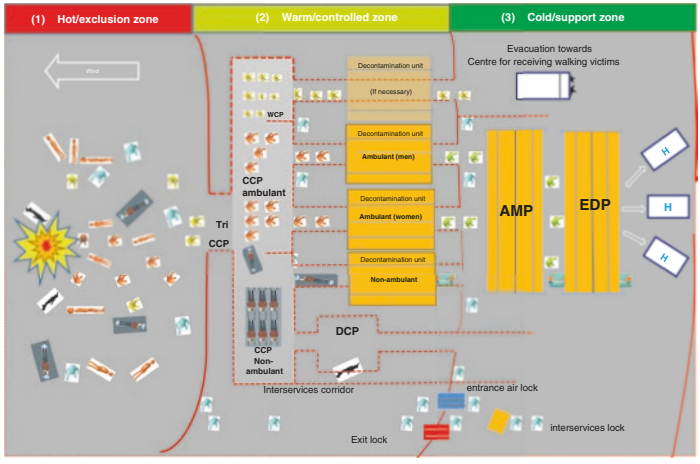

Fig. 13.1 Location of CCP in chemical terroristic attack [1]. *CCP* symptomatic casualty collection point, *DCP* dead victims collection point, *WCP* walking victims collection point, *AMP* advanced medical post, *EDP* evacuation dispatch point

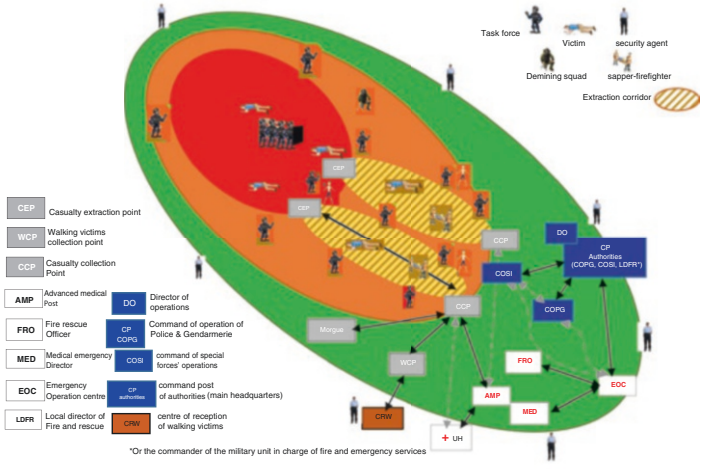

Fig. 13.2 Location of CCP in ballistic terroristic attacks [2]

pharmacists who should be taught and trained to don PPE and to administer antidotes. Responders wearing their PPE should limit their actions to the essential tasks: triage, emergency and maintaining safety measures, and administering antidotes.

A terroristic ballistic attack is another situation where one or several CCPs are deployed at the periphery of the hot zone, at the end of its extraction corridor (Fig. 13.2). The responding rescue and health care staff should don appropriate PPE in order to perform triage (Tri), urgent care, and stretcher transfer through the warm zone towards the single or multiple AMPs.

Apart from these two situations, creating a CCP should not interrupt emergency work but rather integrate it (Fig. 13.3). Direct evacuation concerns only EU cases (5–10% of casualty), without affecting tracking of the entire emergency response (documented triage records) [3, 4]. CCP must meet specific criteria:

- Situated in the warm zone or at its periphery, before the AMP which is located in a safe place;
- Provide extremely urgent care (antidotes, damage control) to very critically ill victims needing life-saving therapies;

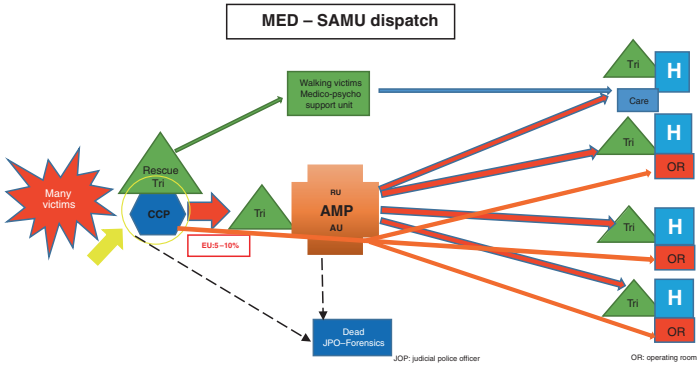

Fig. 13.3 Role and place of CCP in the emergency medical chain

- Enable EU-classified casualties to bypass the AMP, to be immediately evacuated, and consequently undergo urgent surgical procedures. Overall, this does not preclude the rules of primary triage, medical dispatch to decide the destination, and tracking of victims. The time spent for field primary care is already short, however, that should not be at the expense of care quality and tracking.

13.3 What You Should Do

- Setting up a CCP is the responsibility of the competent authority and is part of the overall emergency response;
- Safety measures should be strictly applied i.e. proper donning of PPE and prior exercising;
- All medical and emergency staff should be recognised by the EOC, COPG, or MED and their actions must be integrated into the general operational plan;
- Responders assigned at CCP in chemical or ballistic attacks should don appropriate PPE and have already undertaken specialised training and proper practising, in agreement with the operational authorities;

- Beyond dangerous chemical and ballistic situations, setting up a CCP and the direct evacuation that bypasses field AMP can only be done after approval of MED and/or the dispatch doctor, and concerns only EU cases needing life-saving surgical procedures. Despite the urgency and the imminent danger, victims' tracking should be maintained [disaster records in paper or digital (Single standardised Digital Information system, *SINUS*) versions].

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Rescue in Shooting and Hostages-Taking

14

Matthieu Langlois

14.1 What You Should Know

The concept of tactical rescue in case of "mass killing" is innovative [1] because:

- Interior Security Forces (ISF): LEADING;
- Emergency services: CONCURRENT;
- Neutralising the threat is a priority;
- Organising immediate evacuation of trauma victims who have high risk of bleeding is vital, and should be fast and concomitant, if possible, with actions of ISF;
- Emergency operations follow the security guidelines of ISF to ensure victims' and responders' safety;
- A coordinated evacuation circuit is the one that maintains fluid, adjustable, and non-saturated flow.

Organising tactical zones is coordinated by the commander of operations of police and gendarmerie (COPG) (Fig. 14.1).

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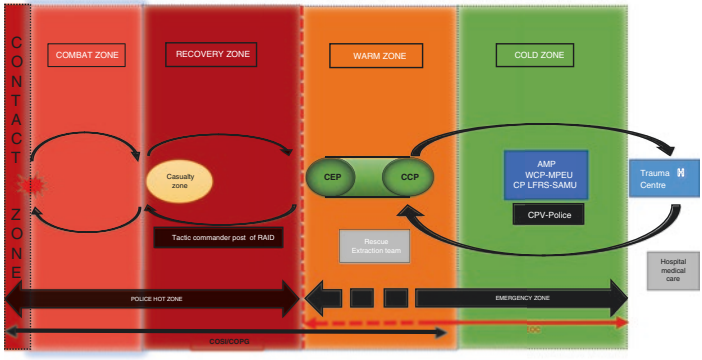

Fig. 14.1 Tactic and dynamic zones (*CP* commander post, *CPV* CP vehicle)

1. The Police Hot Zone (PHZ) Is
- Under real and direct danger;
- Forbidden for emergency operations;
- Bordered by the casualty extraction point (CEP);
- ISF organises the extraction/life-saving measures in the PHZ.

2. The Warm/Controlled Zone (WZ) Is
- Safe with no direct threat;
- Expandable to reduce the hot-zone as soon as possible;
- Hosts the extraction corridor: dynamic circuit between CEP and CCP;
- Accessible for special extraction teams (of sapper-firefighters);
- Under the responsibility of COPG-EOC cooperation.

3. The Cold/Support Zone (CZ) Is
- Totally danger free;
- Accessible for emergency teams;
- Contains AMP, walking victims reception centre, resources collection point (RCP), etc.

Medical care inside the tactical circuit remains simple, effective, **fast**, and synergetic. It should not delay the flow of extraction and evacuation until hospital.

14.2 What You Should Understand

Every type of threat has its specific countermeasures [2]. Effective decision-making and response count on:

- Human, technical, and structural preparedness of teams;
- Shared decision-making between services, validated by the operational coordination of police operation commander (POC), EOC, and MED;
- Anticipation and pre-dispatching;
- Adaptable and dynamic zoning;
- Tactical triage (to accelerate flow).

Two key questions will decide the cooperation strategy between ISF and emergency teams:

- Is it a "sustained combat" or "hit-and-run" scenario?
- Is it an attack with wish to die or to surrender?

The major issue is to find a system that levels victims' and responders' safety and the effective management of casualty whilst absorbing the effects of the initial chaos and uncontrolled time.

14.3 What You Should Do

A. Your Role as the First Responding Doctor on Shooting Scene [3]

- Rapidly analyse the situation (threat and emergency work): situation update;
- Coordinate work between you as first MED and COPG and EOC;
- Set and share the objectives;
- Suggest to COPG some "vital manoeuvres" to forestall unnecessary delay in the management of the most critical victims;
- Understand the zoning (location of CEP/CCP on the map);

- Stay safe on scene;
- Make sure that emergency vehicles follow fluid and safe evacuation routes;
- Assign team members their tasks;
- Set-up reliable communication channels;
- Be ready to rapidly scale up the extraction and evacuation flows.

B. Your Role as a Doctor Operating in the Controlled/Warm Zone (Fig. 14.2)

- Understand the origin of the situation "upstream";
- Share information;
- uphold dynamic work (despite limited resources ++);
- Adjust triage to maintain a dynamic flow of extraction towards CCP;

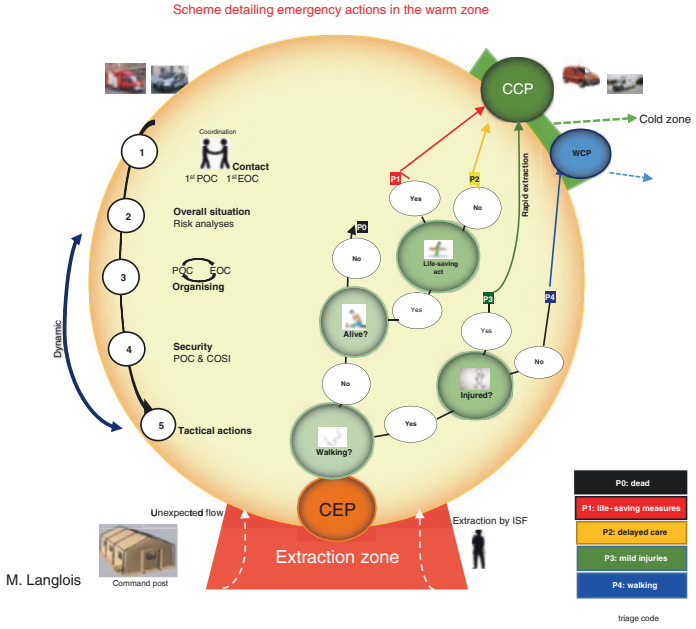

Fig. 14.2 Coordination of tactical manoeuvres in the warm zone

- Anticipate spontaneous and "risky" over flows;
- Adapt the technical procedures according to:
  - Casualty flow/available resources ratio,
  - Evolution of the situation (danger),
  - Speed of extraction flow,
  - Life-saving measures are restricted to those at very high risk of dying.
- Provide reassuring psychological damage control;
- Perform re-triage at CCP to spot ambulant victims who may suddenly deteriorate;
- Prioritise those who are tagged red for direct evacuation to trauma centre without losing time at CCP.

14.4 What You Should Not Do

- Rushing without taking time to analyse the situation;
- Not coordinating the emergency operations with ISF;
- Considering only "medical" parameters that are inappropriate in the context of "mass shooting and killing".
- To be found "trapped" in a situation and unable to evacuate the injured;
- To focus on the work of the others.

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Medical Coverage of Big Crowds

15

Henri F. Julien and Alain Rissetto

15.1 What You Should Know

Events gathering thousands of people, whether planned or improvised, put crowd safety at serious risk incurred by an intercurrent event or sudden crowd movements.

A crowd of more than 5000 people has to be declared to and approved by the administrative authorities beforehand, and a first-aid post has to be installed for the purpose. This becomes mandatory for a crowd of ≥1500 people gathered for profit-making, sportive, or cultural events.

Crowd medical care aims at managing common individual illnesses by the private sector in general, and unexpected community emergencies and disasters by the public sector.

Crowd safety must meet enforceable standards reflected by crowd management plan (CMP) [1].

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15.2 What You Should Understand

Managing Common Risks

Risk factors are known:

- Crowd characteristics: number, density (people in m^2), profile (age, disabilities), event activity (sport, political parade, a mass, etc.);
- Event characteristics: duration, extent, seated or standing crowd;
- Environmental factors: indoor or outdoor, weather (hot, sunny, stormy), darkness;
- Venue characteristics: seaside, near river, rugged terrain;
- Capacity and response time of public emergency services, whether a CMP is set-up or not to manage daily risks or disastrous events.

The required number of responders within the CMP depends on:

- The expected number of people;
- Crowd behaviour: seated and passive audience, standing and actively moving around crowd, dynamic sport or entertainment attendees;
- Venue location and access: distance to transport stretchers, flat or inclined ground, without or with obstructed or congested access and flow;
- Time for public emergency backup to reach the venue if requested.

The recommended medical care service: a medical team trained to manage emergencies of 5000 to 10,000 people; and is adjustable according to the encountered hazards [2].

Predict Risky Situations

Big crowds can turn into disasters:

- Crowd surge or sudden movement that tramples the slow or weakly moving people underfoot, or crush people upon facing obstacles (congestions, fixed barriers, etc.);
- Fires and flames, collapse of structures, terroristic attacks, etc.

Such incidences should be anticipated and monitored by a field unit of the concerned public services (police, Sapper-firefighters, SAMU staff) to form a Command Post, if need be [3], and to deploy logistic means (AMP, MMP, decontamination chain).

The volume, the nature, and the location of emergency logistics are reasoned: close but outside the crowd, in a secure place with safe access, in contact with the headquarters to ensure immediate alerting and optimum management of crowd emergencies.

The field unit should have the necessary means to face such emergencies.

15.3 What You Should Do

- Recognise the large gatherings of more than 1500 people that require prior permission from the local police force or municipality.
- Integrate a voluntary civil protection organisation (VCPO) for the set-up of a crowd management plan, and if necessary an event-dedicated medical service to participate in providing medical care to attendees of events subjected to prior permission. Work in pairs;
- Have a secure and efficient means of transmission (local relays of smartphones are usually saturated in crowd emergencies);
- Anticipate intercurrent disastrous events (terrorism, accidents, etc.), do not put the medical post in the middle of the crowd, but rather on its periphery in a secure place with safe access if possible;
- Present yourself to the on-field public emergency officials;
- Have the necessary health care and emergency materials packed in portable packages (e.g. back-bag);
- Inform the authorities and provide primary report if an unexpected event happens;
- Prepare the arrival and the upscaling of public resources. Behave as a pre-MED.

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Part III

Disastrous Events

Destructive Earthquakes

16

Francis Huot-Marchand

16.1 What You Should Know

The occurrence of many earthquakes is the result of the continuous movement of the tectonic plates. When earthquakes occur with high energy, at shallow depth, and in a populated area, they are destructive.

Earthquakes are natural disasters that in the absence of prevention strategies surpass the local safety and emergency capacities and destroy utility (water pipes, electricity) and transport (routes, bridges) infrastructures.

In such major disasters, the help of special rescue teams coming from unexposed areas is vital (USAR,[1] ADRU,[2] mobile field hospitals, etc.) supported by the mobilisation of all governmental and non-governmental organisations, civil or military associations [1].

[1] USAR: Urban search and rescue.

[2] ADRU: Airborne disaster response unit.

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Earthquakes are foreseeable (seismic zones) but unpredictable (time and place) despite the old and recent scientific research.

The casualty number is directly related to structural collapse caused by the seismic waves, and often increases due to secondary events (fires, landslides, dam or dyke breaks/failures, tsunamis, etc.) and to the poor living standards of the exposed population.

An earthquake is not just a single main shock; it is usually followed by aftershocks, which forces the population not to shelter inside buildings.

16.2 What You Should Understand

Mechanisms
Seismic waves are generated at a breaking point inside the earth crust, and cause destruction mostly near the epicentre.

Assessment
An earthquake is measured by:

- Its magnitude, expressed by Richter logarithmic scale of 1 to 10, and it represents the energy released at the focus of the earthquake.
- Its intensity, expressed by the 12-degree EMS-98 (European Macroseismic Scale),[3] which measures the damage incurred by an earthquake. The earthquake is destructive if scored VIII or more (Table 16.1).

Mortality and Morbidity
The number of victims varies from several dozens to hundreds of thousands deaths, in addition to injured and involved/non-injured people.

[3]Document of the European Centre for Geodynamics and Seismology—Volume 19, Europe Council 2001, http://www.franceseisme.fr/EMS98_Original_english.pdf

Table 16.1 Consequences on buildings

EMS (intensity)	Consequences on buildings
VIII	Chimney fall
	Large deep cracks on walls
	Partial collapse
IX	Many buildings partially collapse and few collapse completely
X	Many buildings collapse
XI	Most buildings collapse
XII	Almost all under or ground structures are greatly damaged or destroyed

- **Trauma**: it accounts for most immediate deaths by crushing and burial; lesions range from limbs crushing syndrome to head trauma and simple or multiple fractures, superficial cuts, to benign bruises, the most common lesions. Burns, smoke poisoning, drowning, etc. caused by secondary events can also be seen.

  On scene and on the front line, the first medical responders are those of specialised urban search and rescue units (USAR), who are trained, equipped, and instructed to work in an active and aggressive environment [2]. Those responders medicate, if required, the recovered victims, knowing that 90% of survivors extricated from collapsed buildings are rescued within less than 48 h after the main shock.
- **Other injuries**: the suspension of basic healthcare services because of collapse of hospitals, destruction of water network, sewage system, power grids, as well as the difficulty of transporting basic life-support products by roads expose the population to risks of epidemics, malnutrition, and deterioration of pre-existing illnesses. Weather and social factors may worsen the situation.

In health establishments, the need for urgent medical care amplifies in the first 24 h after the earthquake, and most victims are managed in the first 3 days.

Devastating earthquakes leave most survivors in psychological trauma.

16.3 What You Should Do

- Identify your individual role within the overall crisis mitigation plan;
- Plan to provide both urgent care to the injured (on-ground, trapped or buried) and general medical care to the population (primary and obstetric health care);
- Include medical care in research and rescue operations if you are equipped, experienced, and have the necessary materials; join a multidisciplinary team;
- Provide health care to all victims and prioritise the most urgent (triage), and set up dispensaries (general medicine, and delivery room);
- Participate in the tasks of the special rescue units to support the spared health establishments and field hospitals;
- Promote prevention strategies (e.g. in Japan) in seismic zones, directed to:
  - Seismic design to ensure seismic-safe building construction;
  - Raise population awareness and encourage their training.

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Cyclones

17

Arnaud Bourdé, Xavier Combes,
and Patrick Portecop

17.1 What You Should Know

Cyclones are devastating meteorological phenomena killing thousands of people a year. Called typhoons in the Pacific regions and hurricanes in the Atlantic Ocean, they are getting even more frequent and violent probably due to global warming. They are responsible for major socio-economic disasters in the developing as well as the developed countries. As violent storms are happening more often in France, acquiring experience in cyclone management is warranted.

Cyclones usually form over the ocean, in the intertropical convergence zone, and generate swirling winds and torrential rain. It is called a cyclone when the wind speed reaches 118 km/h (Force 12 on the Beaufort scale). SAFFIR-SIMPSON scale of 1–5 measures the intensity of cyclone.

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Cyclone detection and forecasting measurements are all the more efficient with six worldwide monitoring centres scrutinising the meteorological satellites data. Their mathematical models provide better measurements of cyclones speed, direction, and intensity, which helps anticipate mitigation plans.

17.2 What You Should Understand

A cyclone is characterised by:

- A cloud mass of several hundred kilometres (km) in diameter;
- A central eyewall, the most active part with the heaviest rain and the most violent winds;
- A calm zone in the centre of this wall, whose size is inversely proportional to the cyclone intensity, giving rise to the cyclone eye.

As the wind nears the centre, its speed accelerates reaching the maximum at the eyewall.

Cyclogenesis requires three factors: eyewall water temperature exceeding 26 °C, low central pressure, and a zone of divergence at high altitude. A cyclone can travel several thousand km at a quite slow speed of 10–25 km/h. It weakens and stalls when it moves over colder water surface or land.

Winds are responsible for substantial damage. When the cyclone eye passes over land, it gives a false impression of calmness, and represents the most dangerous phase.

The torrential rain causes floods and landslides.

The ocean level rises and submerges coastlines with waves reaching 15 m high.

Injuries [1] are mostly traumatic and proportional to the wind intensity. Deaths are caused by drowning, mudslide, or landslide.

Diseases [2] develop later e.g. enteric poisoning by contaminated water, or illnesses related to proliferation of parasites and mosquitos.

17.3 What You Should Do

- **Stay safe** [3]: responses must be very targeted and issued by one command centre. The notion of "impossible to rescue" is real and always difficult to justify;
- **Stay connected**: use emergency satellites phones;
- **Rapidly estimate the extent of the affected zones** [4], which is vital to ensure appropriate response. The army and civil defence airborne resources play a very important role in precisely estimating the number of damaged houses, and the conditions of roads and airports;
- **Organise medical emergency operations** under a unique leadership: organise triage and evacuation norias, and the set-up, if required, of alternative healthcare structures. Provision of food, shelter, and medicines is organised at secured central distributions outlets;
- **Pay particular attention to drinking water and its distribution**;
- **Implement sanitation monitoring indicators** as soon as possible to prevent epidemics;
- **Anticipate and prepare a mitigation plan**: clearly define the individual and group responses to perform before, during, and after the cyclone, as well as the alert stages (Fig. 17.1).

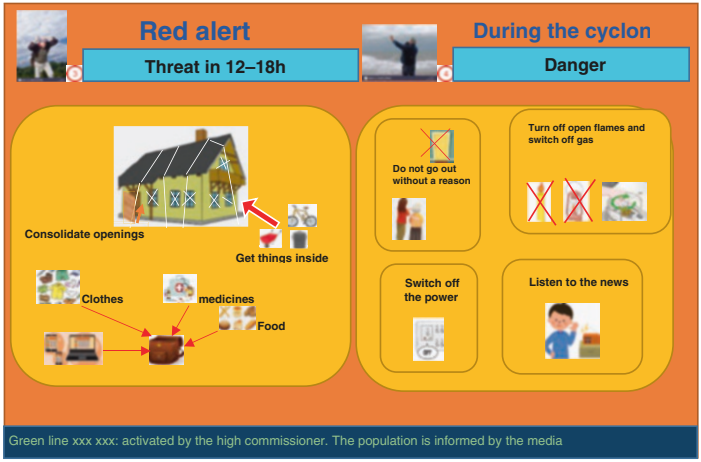

Fig. 17.1 Public campaign to raise awareness on the actions to carry out facing cyclones in the French Over-Sea regions

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Volcanic Eruptions

18

Arnaud Bourdé, Bertrand Guihard,
and Pedro Do Monte

18.1 What You Should Know

Currently, there are about 500 active volcanoes in the world and around 500,000,000 people at direct risk of volcano eruptions on earth. Most volcanoes are found over the subduction zones, at the boundaries of the convergent tectonic plates. There are effusive eruptions that burp rivers of lava, and explosive eruptions that burst and eject lava.

Although destructive (Pompeii, Mount Pelée), generally volcanic eruptions do not induce mass casualty. However, the entire world population can be directly affected because of massive release of ash and gas into the atmosphere.

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Preventive measures and monitoring of active volcanoes nowadays help avoid massive disasters.

18.2 What You Should Understand

There are several types of volcanic activities, but the most dangerous are the explosive eruptions. Danger comes from a series of destructive phenomena, which cause a wide range of injuries:

- Lava rivers, very spectacular, and can flow down at a speed of several km/h, thus rarely cause injuries or death;
- Tephra: particles ejected into the atmosphere during explosion due to variation in gas pressure. Its composition varies from fine ash that can spread to several hundred km away, to real blocks that fall several hundred meters from the crater, to lapilli, the millimetre-sized granules, and scoria, the centimetre-sized granules;
- Pyroclastic flow: a high-speed, very high-temperature glowing cloud that kills people as a result of burns, and is usually preceded by a blast;
- Gas emission: hot and of variable composition (sulphur dioxide, carbon monoxide, hydrogen sulphide and fluoride, and rare gases) causing massive burns and intoxication. In addition, there might be acid rain downwind leading to harmful agricultural and climatic changes;
- Lahars: volcanic mudflows formed by the surge of water resulted from thawed snow or glaciers at the top of the volcano, and travel very fast downslope with a strong destructive effect;
- Tsunamis: can happen secondary to eruption of undersea volcanoes or to the projections of volcanic matters into the sea.

Immediate death is often caused by the pyroclastic flow or tephra, rather than by gas emission and tsunami. Other causes of morbid-

ity include body burns, airways burn (inhaling hot gases), and trauma resulting from sudden close blast. Ash and gas cause various systemic irritations. Inhaling carbon dioxide or hydrogen sulphide is potentially mortal.

Volcanic eruptions are sometimes preceded by a series of small-scale tremors of progressively increasing strength, a good indicator of eruption, which can also be predicated when the gas composition changes. Such indicators allow appropriate measures to be taken [1–3].

18.3 What You Should Do

- **Prepare to the inevitable eruption and its impact** in order to minimise damage. Prevention necessitates continuous monitoring of the volcano to alert and evacuate threatened population in time, thus limit human loss. Preparedness is specific to each country and to each type of volcano (Fig. 18.1);
- **Preventive evacuation of population** is unconditional when it comes to imminent eruption. Alert medical services, set-up the usual health prevention and epidemiological monitoring measures (water, food, vaccinations, shelter), and medico-psychological support (prevention of post-traumatic stress). Handling such populations is a major human and social issue. Exposure to the ash and some gases might require particular monitoring;
- **Stay safe**. Responders should weigh benefits versus risks of working in such risky environments, and always have the approval of the commander of EOC beforehand. Special PPE is often crucial to have: heatproof gear, respiratory protection (mask), and respirators. Helicopters might not be used due to heavy ash clouds;
- **Use VHF radio** in case the satellite phones are disturbed in the dusty zones since the former is slightly affected.

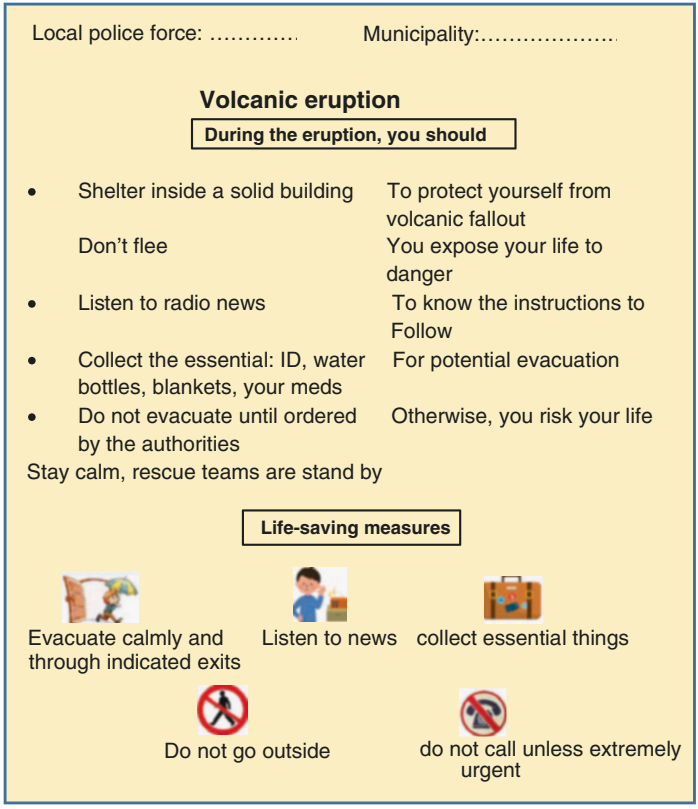

Fig. 18.1 Public campaign to raise awareness on the actions to undertake during eruptions in the French Over-Sea regions

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Cold Waves

19

Jean-Pierre Auffray

19.1 What You Should Know

A cold wave is a period of low temperature weather characterised by its persistence, intensity, and extent. It has health as well as social, economic, and logistic consequences.

The impact on health is more related to the bioclimatic index, which includes wind chill and humidity, than to the measured temperature.

19.2 What You Should Understand

Cold injuries can be direct (hypothermia and cutaneous lesions) or indirect:

- Rise in bacterial and viral infections;
- Deterioration of chronic diseases;
- More traumatic accidents and carbon dioxide poisoning.

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Hypothermia often affects immunocompromised people, young children, elderly people, people with chronic diseases or alcohol or drug abuse, or healthy people exposed to very cold weather with no means of protection.

In cold weather, social and economic insecurity increases vulnerability of exposed people.

Hypothermia develops progressively: mild = 32–35 °C, moderate = 28–32 °C, and severe <28 °C. It causes gradual drop in cardiac output, alteration in muscle activity and consciousness leading to coma and apparent death when body temperature is below 28 °C.

Skin lesions include frostnips and frostbites. Frostnips are characterised by white to grey-yellow skin, a bit painful, and associated with tingling in the cold-exposed parts. Frostbites are caused by tissue freezing where the skin becomes numb, blue-black in colour, and blistered.

These lesions come in four stages and the most severe could end in amputation.

Indirect cold injuries include mainly deterioration of underlying chronic diseases, coronary artery disease, stroke, and high risk of infections.

During cold waves accompanied with snow or icefall, there is more trauma and more road and sometimes train and air traffic jams, which hinder the procurement of supplies and the conveyance of emergency resources.

Cold waves often cause increase in emergency services calls.

19.3 What You Should Do

Anticipation and Prevention

Weathercast services are capable of predicting the occurrence and intensity of a cold wave. They set off the alert that will be relayed at the regional/country level by the activation of the cold contingency plan [1] by the prefect:

- **Level 1 Green alert** is activated every year from first of November to 31st of March (in France),
- **Level 2 Yellow alert**: a 1–2 day cold wave or a period that lasts longer,
- **Level 3 Orange alert**: a period of extreme cold characterised by very low minimum temperature perceived at around −18 °C,
- **Level 4 Red alert**: an uncommon, extreme, and long lasting cold wave that brings along collateral effects in many sectors and paralyses certain activities.

In case of infrastructural damage, black ice, and snowfall, the local prefect can activate the black ice-snow contingency plan in the concerned counties.

Management

- In general, hypothermia is less severe than that observed in prolonged immersion or in victims of avalanche.
- Body temperature should be measured by a low-reading thermometer.
- Hypothermic patients should be sheltered from wind and humidity, covered by light blankets and dry clothes.
- **Depending on hypothermia degree**:
  - **Mild hypothermia of 32–35 °C**. Gradually rewarm the victim without external massage nor direct radiant heat or forced hot air convection. Conscious patients who have no deglutition troubles can drink warm or hot liquids to rehydrate and warm their bodies under observation.
  - Even in mild hypothermia, patients should be hospitalised especially if have pre-existing diseases.
  - **More severe hypothermia of < 32 °C** with impaired consciousness: patients should be transported in an ambulance under monitoring (risk of arrhythmia) towards an ER or an ICU. Moderate and progressive external rewarming coupled with progressive rehydration using warm solutions at 35 °C and oxygen therapy can be initiated at the prehospital phase. Extracorporeal blood rewarming is rarely indicated to increase core temperature in these cases.

Patients with skin lesions resulting from frostbites should be admitted to the ER with no prior prehospital management.

For health establishments and in case of high hospital pressure associated with staff shortage due to commuting troubles, reorganising staff shifts and then activating the contingency plan can be considered. In case of long-lasting or extreme cold wave with significant impact on health sector, ORSAN Climate plan can be activated to mobilise all health and medico-social institutions.

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Heat Waves

20

Jean-Pierre Auffray

20.1 What You Should Know

Heat waves are periods of excessive high temperature observed over several consecutive days. In France, what we call "*canicule*" is a severe heatwave where day and night temperatures exceed the regional thresholds for at least 3 days. Heatwaves have considerable health effects in terms of high morbidity and mortality.

20.2 What You Should Understand

Children of less than 5 years and adults of more than 75 years are at higher risk.

Certain diseases and therapies reduce the body thermal regulation capacity, hence the higher risk.

Urban and precarious housing and exposure to pollution increase the risk of complications. Heatwave injuries include four clinical presentations:

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- **Dehydration**: dehydration and hypovolemia will give rise to hyperthermia due to the diminished sweating and the failure to increase the cardiac output. On the other hand, when hyperthermia sets in and there is insufficient water intake, the patient will soon have dehydration.
- **Heat exhaustion**: is the most common presentation in the elderly and those at risk. Patients show severe fatigue, high body temperature (<40 °C), headaches, nausea, vomiting, dizziness, hypotension, haemoconcentration, hyperkalaemia, and functional renal failure. Untreated or poorly treated, it will evolve into heat stroke.
- **Heat stroke**: is the most serious presentation with high mortality in the elderly (50%). It is characterised by neurological signs, convulsion, coma, body temperature of >40 °C, hypotension, acute renal failure, and multiple organs failure.
- **Exertional heat stroke**: during heatwaves, professional or sportive activities could lead to heat stroke especially when coupled with prolonged effort, hot environment, inappropriate clothing, and absence of acclimatisation. Its main clinical features are severe fatigue, dry skin, malaise, convulsion, coma, hyperthermia of >40 °C, and rhabdomyolysis. In young adults, the mortality is of 5–10%.

20.3 What You Should Do

Preparedness

Depending on the bioclimatic data and the assessment of the heatwave duration, the weathercast services will issue four alert levels [1]:

- **Level 1** = Seasonal monitoring represented by green colour on the weather alert map. This level is automatically activated from first June to 31 August every year (in France).
- **Level 2** = Heat warning, it is highly monitored to ensure optimum readiness of concerned services.
- **Level 3** = heatwave warning is triggered based on bioclimatic data and health indicators in agreement with regional health

agencies (RHA). At this level, the public services and the municipal officials organise prevention and management in alignment with the heatwave intensity and duration.
- **Level 4** = maximum readiness, red weather alert. This level indicates an unusual extreme heatwave, very severe and long lasting.

Individual Medical Care
- Prevention consists in gathering vulnerable population in cool and ventilated places with proper intake of water to keep hydrated (without over-hydration which causes hyponatremia).
- Dehydration does not always require hospitalisation. It could be treated with progressive oral rehydration and moving the patient to cool places.
- Heat exhaustion often requires hospitalisation if the patient is old or has comorbidities. The basis of treatment is oral or parenteral rehydration and external body cooling. Treatment could start at prehospital phase.
- Heat stroke and exertional heat stroke are emergencies that should be treated urgently at prehospital phase by intensive external cooling (cold water or ice bath, forced air convection) associated with parenteral rehydration and oxygen therapy. Antipyretics are useless and dangerous. Admission to ICU is recommended.

Community Medical Care

Heatwaves are accompanied by an increase in emergency medical calls, which in turn increases hospital pressure. For such, health establishments should mobilise their resources and reorganise their staff shifts and, if need be, upgrade their response by activating their contingency plan in compliance with the recommendations of ORSAN EPI-CLIM plan: manage emergencies downstream flow by adjusting hospital capacities in general medicine, geriatrics, and specialised infectious diseases wards, and treat critical cases in ICU (Fig. 20.1).

Fig. 20.1 Public campaign to raise awareness of workers on actions to undertake upon working in hot environment

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Disasters and Epidemics

21

Benoît Vivien

21.1 What You Should Know

Disasters, whether man-made or natural, are not the direct cause of epidemics.

Dead victims, not initially infected at time of death, generally do not harbour infectious diseases that could generate epidemics.

Apart from some specific pathogens (in particular cholera, Ebola, smallpox), most "classical" infectious agents present in corpses cannot survive more than 48 h outside.

21.2 What You Should Understand

Overall, disasters usually cause destruction of many infrastructures, mainly sanitary networks e.g. sewage system and potable water pipes.

The presence of people in such insanitary conditions, in overcrowded and not well-equipped camps considerably increases their health risks (Fig. 21.1).

The original version of the chapter has been revised. A correction to this chapter can be found at https://doi.org/10.1007/978-3-031-00654-8_51

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Fig. 21.1 Population using contaminated water despite the interdiction. Mexico, earthquake 1985

The risks for the population health are basically related to specific pathogens (cholera, Ebola, smallpox, etc.) present in the corpses, particularly in their stools, which might contaminate water sources.

The immediate health risk for the population is negligible provided that no one touches or handles the dead bodies.

Among the various hazardous infectious agents linked to disasters, cholera stands high. It causes acute diarrhoea after ingesting food or water contaminated with *Vibrio Cholerae* bacterium.

- Its short incubation period (12 h to 5 days) enhances the dynamic widespread of the epidemic;
- About 75% of *Vibrio Cholerae*-infected people are asymptomatic;
- If symptomatic, 20% develop watery diarrhoea, which is potentially fatal due to acute dehydration.

21.3 What You Should Do

On scene, responders are exposed to such epidemics and need to be protected [1]:

- There is no officially recommended vaccine for professional responders outside the classical vaccination programme advised to take before entering the country concerned by the disaster;
- There is no particular prophylactic agents for professional responders to take outside the classical prophylaxes usually taken before entering the country concerned by the disaster e.g. antimalarial medicines;
- Responders should strictly apply individual and group hygienic measures, and don the appropriate PPE beforehand (mask, gear, gloves, etc.)

The mitigation plan should include immediate measures to reduce the risk of development of epidemics:

- Restore sanitary infrastructures, in particular potable water network and sewage system;
- Implement primary care services;
- Mass vaccination (measles, typhoid, etc.);
- Prevention of certain diseases (malaria, dengue fever, etc.);
- Implement an epidemiological surveillance and alert system.

Raising the population awareness towards the risk of epidemics is essential and represents the bottleneck in the management of disasters.

Management of dead bodies is a key point in the prevention of epidemics [2], however, funeral rites could interrupt the safe management of corpses.

- Recovery of corpses is carried out by dedicated personnel wearing a special gear (gloves and boots), in compliance with standard hygienic measures;

- Preserving corpses in refrigerated containers is the best option; failing that, temporary burial can be a solution within certain rules (depth, distance between bodies, identification or simply tagging).

Treating cholera epidemics requires [3]:

- Oral rehydration solution (ORS) to compensate water and salt loss;
- Parenteral rehydration with antibiotics in severe cases;
- Oral vaccination for vulnerable population living in high-risk zones.

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Dwellings Fires

22

Kilian Bertho and Bertrand Prunet

22.1 What You Should Know

Home fires carry double threat, the fire itself and the potential presence of many victims.

In France, it kills every year 800 people, most often vulnerable ones: sleeping (2/3 of deaths happen at night, hence the importance of having fire alarm), young age, elderly, and of low socio-economic level [1].

The main cause of death is fire smoke [2], and much less burns or trauma due to fall from heights.

Factors in favour of fire mortalities are: if happens during deep sleep (12–6 am), buildings of six floors or higher, hotel, health establishment, old building, disadvantaged people, fire at lower floors, defenestration, difficult to access by firefighters.

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22.2 What You Should Understand

Home fire is a real risk explained by its potentially high caloric value (density of furniture), the probable presence of piped gas, and the risk of propagation via the existing communications.

Buildings of 28–50 m high represent the highest risk dwellings since they house a big number of people, and the floors above 28 are not or hardly accessible by ladders, and have no fire doors or compartments. Their maintenance is sometimes insufficient and the fire safety system might be deficient.

Fire-fighting services prioritise certain actions when they respond to a fire. Medical emergency measures are usually coupled with these actions to ensure outcome, however, all start by simple acts e.g. not to park vehicles where they block access of fire engines to the building.

The final number of dwelling fire victims (hence the required staffing) can be estimated by multiplying the initial number (reported by the first medical responders [3]) by a factor of 2.5.

Mitigating such incidents imposes early deployment of an AMP to receive victims.

Families and involved/non-injured people should be gathered and managed in a separate place.

Characteristics of High-Rise Building (HRB)

HRBs have strict regulations to meet [4]. They should have fire safety system with central control station (becomes the main commanding post of EOC in fires).

The structure relies on fire-supressing compartments built every two floors to hold fire at least two hours, and each has two pressurised staircases and two pressurised lifts to avoid smoke spread.

The frontline command post can be installed two floors below the fire where medical triage of victims can be performed, if needed.

Specificity of Hospitals or Nursing Homes Fires

Casualty of hospitals or nursing homes fires involves mainly vulnerable or disabled people. Such fires are defined by their origin (room or technical premises), the building type (residential or apartment building), and type of hospitalised patients (young children, disabled adults, ICU-patients).

One of the key points is to maintain the utility system streaming (water, electricity, and medical gases) as much as possible.

Another point to pay attention to is the establishment activity: what are the ongoing medical activities (operating room)? Which one can be interrupted? Which must be maintained (ICU, ER)? Is load shedding possible?

Depending on fire evolution, it is advised to anticipate patients transfer: horizontally (in the same floor; fast and labour-saving yet does not distance them a lot from fire) or vertical (change floor or building; substantially laborious, slower, but provides better protection from fire).

22.3 What You Should Do

- Stay safe. Do not expose yourself to unnecessary risk;
- Contact EOC. Gather information on the fire, ongoing rescue operations, possible bottlenecks, and risk evolution;
- Establish a health relief plan coordinated with EOC;
- Assess casualty (type, number, and multiplicative factors)
- Have an AMP set up (safe, nearby, accessible, and ergonomic);
- Send a circumstantial report to help adapt reinforcements:
  - Context: fire nature, difficulty, progress of field operations,
  - Casualty,
  - AMP location and access,
  - Request for resources
- Start triage of victims
- Ensure medical care is provided
- Anticipate evacuation in coordination with dispatch centre
- Set up a centre for involved/non-injured

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Fire Smoke Inhalation

23

Luc Ronchi

23.1 What You Should Know

This kind of accidents occurs mainly in a confined area, during sleep, and more in children. It is often collective in nature (hospitals, nightclubs, passengers).

Fire smoke causes substantial mortality and morbidity.

Intoxication is bimodal: direct inhalation to lungs (heated particles, bronchial obstructions) and systemic (combustion products).

The resulted hypoxia is multifactorial: inhaling fire smoke in a confined area lacking oxygen, burning the respiratory tract, inhaling carbon and cyanide monoxides [1] (Fig. 23.1).

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Fig. 23.1 Stratification of the smoke on the ceiling. Photo Brigade SP of Paris

23.2 What You Should Understand

The circumstances of the causative event (fire in a closed structure) are precious tools to orient the diagnosis. The primary challenge is to extricate the victim without exposing the rescuer(s) to the same risk.

Carbon monoxide (CO) disrupts oxygen (O_2) transport and delivery to cells (haemoglobin has higher affinity for CO than for O_2) leading to cerebral hypoxia and alteration of cardiac and muscles contractility.

Cyanide prevents cells from using O_2 by blocking the mitochondrial Krebs cycle resulting in lactic acidosis.

The initial clinical features are variable (fatigue, polypnoea, altered mental status, convulsion, shock) and misleading [2].

The presence of soot at nostrils openings and oropharynx indicates smoke inhalation and should drive attention to associated smoke poisoning.

Collapse or shock could be a sign of associated internal haemorrhage (blast injury secondary to explosion during the fire).

High-flow oxygen therapy has a wide range of indications.

Installing a peripheral intravenous line (intraosseous if needed, especially in children) allows to rehydrate (collapse) and to inject antidotes, and even to facilitate endotracheal intubation (RSI (Rapid sequence intubation) to induce general anaesthesia).

Endotracheal intubation has relatively broad indications, particularly in face and neck burns where secondary local oedema develops and can make intubation difficult if performed later.

Antidotes are selected according to their mechanism of action and their side effects:

- Methaemoglobinising molecules are no longer indicated since they cause decrease in blood oxygen transport;
- Thiosulfate transforms cyanide into thiocyanate (not toxic), however, its slow action precludes its indication in such poisoning;
- Dicobalt edetate (Kelocyanor®) has many side effects (hyper/hypotension, arrhythmias, hypoglycaemia);
- Hydroxocobalamin (Cyanokit®) turns cyanide into cyanocobalamin (not toxic). It works fast and with few side effects. Thus considered the drug of choice to treat cyanide poisoning at a dose of 5 g IV in adults (70 mg kg^{-1} in children).

23.3 What You Should Do [3]

- Follow the safety instructions given by the EOC commander;
- Roughly estimate the proportion of children among the other casualty (eventually ask for paediatrics personnel);
- Rapidly provide all victims with oxygen therapy (high flow oxygen mask FiO_2);
- Intubate and ventilate all victims with serious consciousness disorders (GCS < 9) or burns of the airways (risk of secondary oedema);

- Thoroughly examine the victims to look for trauma especially in case of defenestration (panic reaction) or explosion;
- Set a reliable IV line (fluid therapy, antagonist injection);
- Decide which antagonist to give if have signs of smoke inhalation (presence of soot in the nasopharynx, dysphonia, conjunctival irritation) associated with unexplained circulatory or haemodynamic abnormalities;
- Use hydroxocobalamin (Cyanokit®) as the antagonist:
  - Reconstitute with the diluent (0.9% NaCl), included in the kit,
  - Use the IV perfusion tubing provided in the package (anti-particles filter ++),
  - Infuse over 15 min; renew the dose after 15–120 min according to clinical response.

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Explosions

24

Kilian Bertho and Bertrand Prunet

24.1 What You Should Know

Explosion is the almost-instantaneous transformation of a solid or liquid material into gas generating rapid expansion in volume perceived as a pressurised wave called shockwave that propagates in all directions associated with the release of extremely vigorous energy.

Explosions are violent, destructive, and affect a big number of victims at the same time.

Blast injuries are the first cause of military injuries; however, terroristic threats force the civilian community to develop an appropriate concept to manage these complex injuries. The same scenario could happen in industry and in nature (lightning).

24.2 What You Should Understand

A shockwave propagates in all directions. We can distinguish deflagration where the pressure wave travels at a velocity slower than

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the sound speed, and a detonation wave which travels at a supersonic velocity. The latter is seen with high explosives.

The shockwave velocity depends on the medium in which it propagates; the lowest in air followed by liquid then solid. In air, it travels at 4–8 km/s, in liquids at around 4 times faster, and in solids 15 times faster. The shockwave attenuates and dampens with distances depending on the nature of materials (Table 24.1). In air, it also depends on the degree and mode of confinement: attenuation is faster in spherical propagation (open space, three dimensions), slower in radial propagation (a room in a house, two dimensions), and very limited in axial propagation (narrow tunnel, one dimension) [1].

Explosion Situations

Can happen at work or industrial sites [2] accompanied with many phenomena [3]:

- **Unconfined vapour cloud explosion (UVCE)**: a cloud of explosive gas ignited upon contacting a heat source and the front of the flame propagates inside the cloud generating a pressure wave;
- **Boiling liquid expanding vapour explosion (BLEVE)**: rupture of a liquefied gas reservoir generates violent evaporation and explosion of the entire tank. The danger here depends on the size of the reservoir and the quantity of the gas cargo;
- **Dust explosions** [4]: coal dust and cereals silos.
- **Explosions in a warehouse of aluminium nitrate-based fertilisers**: this fertiliser is a precursor of explosives. Historical examples: Oppau, AZF, and Beirut recently;
- **Backdraft**: explosion of smoke in a fire due to unexpected entry of oxygen;

Table 24.1 Propagation and damping of shockwave

	Air	Water	Solid
Wave length	Short	Short	Long
Velocity	365 m/s	1600 m/s	2000–10000 m/s
Damping	200–300 m	300–1500 m	2–10 m

m/s meter per second

- Explosion of pressurised gas or air reservoirs; dangerous if happens in a confined space;
- Nuclear explosions like Chernobyl or Fukushima where danger comes from radioactive emissions.

Protection from explosion is the responsibility of the industrialists. Avoid introducing a heat source into an explosive atmosphere (ATEX directive), respect safety distances, and insert barriers.

Be careful of wave propagation via ship decks, structure of armoured vehicle, and walls which could transmit the shockwave.

Shockwave Effects

The primary injuries [5] of shockwave are those related to the blast. Body organs have variable susceptibilities according to the intensity of the shockwave. As for hollow organs, the ascending order of organ susceptibility is as follows: auditory, respiratory, then digestive lesions.

If the shockwave is so violent, it can cause traumatic amputations.

The sudden expansion in the gas volume generated by the explosion causes serious injuries because of projectile particles and shrapnel. Those are the most common injuries.

The blast can also displace victims themselves (against walls, or fall from height, etc.), or destroy buildings (collapse on the victims, burial). Overall, it causes a myriad of injuries, crush syndrome, and asphyxia due to entrapment.

Quaternary injuries include the other explosion-related effects: heat (burns), toxic substances (smoke poisoning), or even psychiatric (acute stress or post-traumatic stress syndrome).

24.3 What You Should Do

On Scene

- Follow safety instructions and avoid unnecessary exposure to danger. Work respecting the recommended distance and in coordination with the rescue team;

- Take the event history: assess the intensity of the explosion (causative agent, effect on the infrastructures, open or closed area), victim location from the explosion (projectiles, protective barriers, contact with structures propagating the shockwave);
- Apply damage control in case of haemorrhagic lesions (multiple trauma or shrapnel) and prioritise them in triage;
- Look for lung symptoms, even minimum, and abdominal lesions: clinical examination, FAST ultrasound. Manage burns.

During Transport

- Lay the victim in recovery positions: half seated if lung injuries, elevated feet if abdominal injuries;
- Pay attention to hollow organs injuries before considering air transport.

At Hospital

- Damage control surgery, taking into account the risk of sepsis;
- X-ray and CT-scan imaging in case lung lesions are suspected;
- Management of acoustic trauma and internal lesions if present;
- Look of abdominal lesions.

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Nuclear and Radiological Accidents

25

Luc Ronchi

25.1 What You Should Know [1–3]

The origin of these accidents is diverse: nuclear war, accident in an industrial site, transport accident, terroristic attack, and loss of a sealed radiological source.

There are pre-established preparedness plans (to face planned, emergency, and post-accident situations) for the public and for the concerned emergency services.

RAD risk does not give rise (except in massive irradiation) to immediate alerting symptoms.

It is imperative to protect all responders during the entire rescue and victim management process.

It is possible to have additional traumatic injuries (explosion, attack), which will interfere with the management of victims.

25.2 What You Should Understand

Radio-nuclear (RD) events bring about a wide range of consequences: from the explosion of a nuclear power plant (Chernobyl,

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Fukushima) to the observation of more or less deep musculocutaneous lesions on a localised skin surface in a small group of people (an out-of-use radiotherapy source left in a scrapyard in Brazil, cut up by scrap dealers and sold as a metal).

The radioactive isotopes of iodine and caesium as well as certain actinides (Uranium, Americium, Plutonium) are the most common radioactive agents detected in such accidents.

Irradiation is harmful due to the cytotoxicity it induces. Tissues vary in their susceptibility (haemopoietic and cerebral tissues are the most vulnerable). Irradiation affects cell structure (necrosis) and nuclear DNA (on the intermediate or long term, radiation-induced cancers develop).

Irradiation is not "contagious" i.e. not transmissible. Its quantification is performed by special techniques that are rarely used in acute incidents apart from industrial accidents.

Contamination occurs via the radioactive micro-particles emitted by the causative agent; they will attach to various media (hair, skin, mucosa) and form numerous micro-sources of irradiation that can generate the same effects as the initial source.

Thus, one can be contaminated even at a very far distance from the RN accident (consuming vegetables or animal products already contaminated by the radioactive cloud dispersed by wind e.g. Chernobyl accident). Contamination is transmissible, especially from victims to rescuers if no precautions are taken. Looking for contamination necessitates the use of a radiometer connected to an external probe to detect radiation emitted by radioactive particles present on the clothes or skin of the contaminated person. The devise allows only to detect (hence alert) with no possible quantification.

Decontamination relies on four imperative measures:

- Not to over-contaminate the victim (apply strict stripping procedure);
- Not to allow external contaminants to enter the body (no foods or drinks are allowed before proper and effective decontamination, have victims wear protective masks (with filters) during the procedure);

- Not to allow contamination to spread into the environment (strict management of effluent);
- Not to contaminate responders.

The critical deterioration in health should drive attention towards the presence of one or multiple associated traumatic injuries. Unlike chemical poisoning (neurotoxic, cyanide), exposure to radioactive contamination cannot explain by itself circulatory or respiratory collapse, especially when there is a history of trauma or blast. Look for associated traumatic lesions.

25.3 What You Should Do

- Consider this exposure when circumstances suggest it, wait for results of special units intervention if in doubt;
- Wear special light decontamination PPE (TLD);
- Do not neglect physical examination which, combined with the accident circumstances, could indicate the need for emergency surgery;
- Have victims immediately wear facial masks to prevent the contaminants from entering their bodies via inhalation or ingestion (no drinks, no food, and no smoking);
- Spray water on clothes and skin in open air in order to avoid spread of contaminated particles;
- Proceed with victims disrobing following a specific technique (roll up the stripped clothes) to avoid spread of contamination;
- Rinse wounds with DTPA solution then wrap them up;
- Lead the victims through the decontamination chain except for urgent cases requiring immediate surgery who will be, after prior agreement, sent directly to the concerned wards. Wrapping the injured in double vinyl sheets and informing the receiving medical wards is vital so that the latter could take all standard measures to avoid dispersion of radioactive particles during hospitalisation. Medical and surgical emergencies are prioritised over decontamination;

- Order CBC (complete blood count) samples for all victims and repeat the test as needed (prognostic value of lymphocytes decay slope).

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Traffic Accidents Involving Many Victims

26

David Serrano and Arnaud Bourdé

26.1 What You Should Know

Road traffic accidents have considerably decreased despite the increase in the traffic.[1] Nonetheless, we still have some difficult situations generated by a big number of victims that surpasses the usual capacities and/or when scene accessibility or the extrication of victims are compromised.

Tourist bus accidents represent the typical model of limited-impact disastrous accidents (LIDA), which deviate emergency medicine from its daily work to dealing with uncommon situations.

Such accidents occur on motorways, in rural areas or mountains. They are often associated with poor weather and road conditions, worsened by the interaction of heavy goods or public transport vehicles. All contribute to delaying and complicating emergency operations.

[1] https://www.onisr.securite-routiere.gouv.fr/.

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Sometimes, the accident causes tens of deaths, which represents striking news that turns emotional when children are engaged.

26.2 What You Should Understand

Road traffic accident is a violent and brutal event.

Certain circumstances complicate emergency operations:

- bad weather conditions: fog, rain, snow, and ice that will delay the arrival of emergency teams and complicate their work;
- difficult-access geographic locations: mountain roads, tunnels, rural roads, or even motorways with backlog of vehicles;
- entanglement of a light metal sheet made tourist bus with a heavy metal sheet made lorry or public transport vehicle; the latter require special extrication equipment;
- the transported fuel (light vehicles or lorries) may ignite and spark fires and perhaps explosions.

The required resources must be summoned very early.

Free and possible access, zone of collection of resources, zone of deployment of AMP, and the helicopter-landing zone, are so many elements the first medical responder on the scene should report to the on-scene authorities and to the call centres.

The response to these accidents concerns many sectors: field safety (police), first aid, extrication, and firefighting (sapper-firefighters), on-scene medical care, evacuation, and hospitalisation (health staff).

Every team of care-providers should first rapidly assess the accident characteristics, roughly estimate casualty number, identify injuries requiring immediate care (triage), and control external bleedings.

The primary urgent action is the identification of casualty requiring local haemostasis and surgeries for their injuries since their mortality is time-dependent (time lapse between initial trauma and arrival at medical imaging unit then surgical ward to stabilise their conditions) [1].

Anticipate reception of these cases at hospital and promptly identify and inform the concerned wards.

26.3 What You Should Do

- As the first doctor on scene, request the activation of NOVI plan on arrival and confirm the accidents collective nature;
- Undertake the functions of the temporary MED [2], pre-MED. Take the time you need to form an overall and objective vision of the situation before starting any medical care.
- This reconnaissance work will be conducted in cooperation with the first commander of EOC;
- Transmit information to the dispatch centre;
- The roles of the MED and EOC will rapidly be delegated to the most experienced and trained staff, if necessary;
- Identify casualty and perform triage. For the most critical (bleeding requiring surgery), directly evacuate them to surgical facilities, where there are free beds, after informing them. The other victims can be managed inside the rapidly deployed AMP before evacuating them, according to dispatch centre, by all road and air-transport means;
- Activate hospital special procedures dedicated to organising victims' reception, in particular, "massive influx of victims" plan (AMAVI);
- Control patients' flow to avoid saturating medical imaging and surgery facilities;
- Call in the medico-psychological emergency care unit (MPEU).

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Railway Accidents

27

Benoît Vivien

27.1 What You Should Know

The worst train crash in France happened in Savoie in 1917, during WW1, and killed 425 of the 1200 military passengers who were returning home from the Italian frontlines.

Railway transport is one of, if not, the safest means of transport. However, it is exposed to potentially serious accidents that generate heavy casualties.

There are two main types of railways accidents that can cause each other:

- Collisions, between trains and/or with a land vehicle, particularly on a level crossing;
- Derailment, spontaneous (excessive speed) or due to deteriorated or derailed tracks (rail or shunting failure, landslide, etc.)

The two main challenges for first responders are to maintain railway traffic on adjacent rails and, if the accident is on a line with

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electric overhead catenaries, to maintain safety as long as the main power is not shut down.

Accidents involving freight trains transporting hazardous materials (HAZMAT) bring along chemical and/or fire/explosion (fuel) risks.

Railway accidents occurring in a tunnel, a fortiori when followed by a fire, can release smokes that are toxic to passengers as well as to first responders.

The exact location of an accident on a rail line is given in a kilometre point (KP) to help identify the nearest road access points.

Terroristic or malicious acts should always be suspected in railway accidents.

27.2 What You Should Understand

Sometimes, train accidents happen in areas difficult to reach by land vehicles and/or by helicopters:

- Tunnels, bridges, and viaducts;
- Railway lines at very far distances from land roads.

A train crash can injure the inside passengers as well as the outside pedestrians (on the quay of a station).

There is always doubt about the initial casualty estimates, which is mainly dependent on the number of passengers, not to mention the impact on the environment (chemical pollution) or the occurrence of a secondary accident (HAZMAT).

Accidents of high-speed trains can cause major multiple trauma with a wide range of injuries to the passengers:

- Direct collision causes bone injuries, mostly closed traumatic injuries (limbs, skull, chest, spine, pelvis);
- Train deceleration injuries (heart and big vessels);
- Injuries of compression and entrapment;
- Open trauma by projectiles or being struck by blunt objects (crumpled metal sheet);
- Ejection.

Two types of obstacles can block the access of healthcare teams to the scene: train location (rural roads, tunnels, viaduct), or victims trapped inside a rail wagon at high altitude requiring ladders.

Chest and brain trauma are the main cause of death in train accidents.

Life-saving amputations are sometimes necessary to release victims entrapped in very thick metal sheets.

The psychological trauma is all the more serious as trains are considered as a very safe transportation means.

The nearest hospital to the crash scene might be small i.e. might become saturated in a short time and fail to contain massive casualty influx.

27.3 What You Should Do

- Historically speaking, and just as described in disaster medicine [1], a train accident has always been the standard model on which field medical chain preparedness [2, 3] is based.
- The first responders arriving on scene by helicopter can take aerial photographs of it, which is particularly important for the deployment of the field medical chain (Fig. 27.1).
- Both MED and EOC should contact the operator or their representative.
- If the accident happens near a station, better deploy the AMP inside the latter. Discuss with the EOC and the operator crisis director the possibility of implementing the AMP inside a wagon that will then be towed to the station.
- Transporting blood products (packed RBCs, packed plasma) to the site or AMP seems necessary in case of prolonged release of victims and/or predictable long-distance evacuation.
- If the release operation is taking time, anticipate more resources to support the medico-surgical teams.
- One of the priorities of prehospital management is to avoid crush syndrome via fluid resuscitation and alkalinisation.

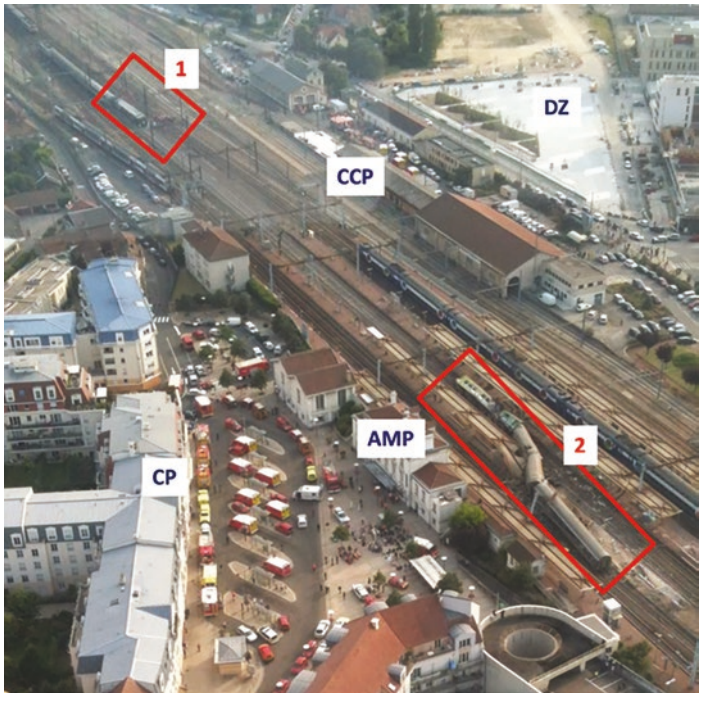

Fig. 27.1 Train accident of Brétigny in 2013. Emergency chain set up. Photo by B. Vivien

- The early deployment of medico-psychological support and the management of non-injured victims as well as the relatives and dead victims are vital.
- Major train accidents with heavy casualties attract media's attention and necessitate proper institutional communication by the State officials and not by the field medical officers.
- Disaster medicine courses include field exercises and simulations of train accidents, and those are essential elements for proper preparedness plans.

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Warfare Chemical Agents

28

Stéphane Travers

28.1 What You Should Know

The Chemical Weapons Convention (CWC) has unfortunately not prevented the use of chemical warfare agents (Sarin, chlorine, and mustard gas) in recent conflicts.

Terroristic use of chemical agents, attacking industrial plants, or more simply industrial accidents are real threats not to ignore.

The main clinical outcome of exposure to military and industrial chemicals is multifactorial hypoxia. Its treatment is essentially symptomatic and sometimes etiologic if there is antidote (Table 28.1).

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Table 28.1 Clinical signs and readings of hand-held detectors to monitor contamination (AP2C and AP4C) by major chemical agents requiring administration of antidotes and/or wet decontamination

History and clinical signs	AP2C and AP4C readings	Possible chemical agent	Main treatments and antidotes	Need for wet decontamination
Eye irritation, cough, respiratory distress, lesional acute pulmonary oedema after a possible remission phase	AP2C− AP4C−	Choking agent	O_2	
Bronchospasm, bronchial hypersecretion, visual troubles: most often miosis, fasciculation, seizures, coma, headache, nausea, incontinence	AP2C and AP4C + (phosphor)	Neurotoxic organo-phosphate (NOP)	O_2 Atropine Valium Oximes	Yes If liquid or aerosol
Oily liquid, no immediate symptoms. Delayed presentation of eye, skin, and respiratory burns	AP2C and AP4C + (sulphur)	Blister agent (mustard gas)	O_2	Yes
Serious eye irritation then pain Pruritus, erythema, greyish skin areas, SOB,[a] tracheobronchial lesion	AP2C− AP4C+ (As)	Blister agent (Lewisite)	O_2 BAL®	Yes
Anxiousness, agitation, coma, seizures, collapse, SOB, mydriasis, cardiac arrest	AP2C− AP4C+ (HNO)	Cytotoxic Cyanide-derived agent	O_2 Hydroxocobalamin or Dicobalt edetate	
Bradypnoea, apnoea, impaired consciousness, miosis, cardiac arrest	AP2C− AP4C−	Opioid	O_2 Naloxone	

BAL® British anti-lewisite

[a]Shortness of breath

28.2 What You Should Understand

The CBRN circumstantial emergency actions should unite two principles [1]:

- Not to delay or downgrade effectiveness of victim's care:
- Not to contaminate health responders and hospitals' structures.

Some liquid or solid chemical agents can be dispersed via contaminated particles/dust, hence the need for decontamination (Table 28.1). A simple shower suffices to eliminate water-soluble agents; however, it spreads them on the skin if insoluble (e.g. blister agents).

Others (especially gases) are highly toxic, yet with lower contamination risk. Stripping is essential here to avoid dispersing contaminated particles attached to clothes (exactly what happened in Tokyo or with many chlorine gas attacks) and it often seems sufficient to engage "classical" management of patients.

28.3 What You Should Do

Emergency and medical teams at risk of exposure to chemicals should respectively[1] [2] (Fig. 28.1):

- **Protect themselves** (stay in open air, define dangerous zones, and don proper PPE before entering them);
- Extract victims to open air, take off their clothes (or at least have them strip the outer layer of clothes), and then, if possible, initiate emergency dry decontamination using decontamination gloves or Reactive Skin Decontamination Lotions (RSDL);

[1] Newsletter no. 700 of 2 October 2018 concerning national doctrine of implementing emergency and healthcare resources facing terroristic attacks using chemical warfare agents.

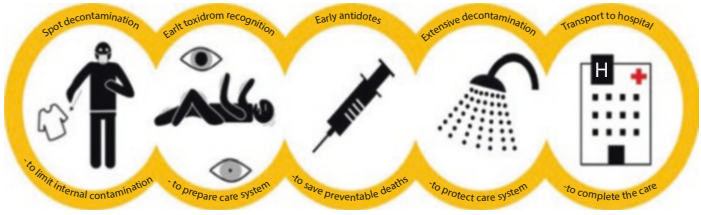

Fig. 28.1 CBRN chain of survival, by Calamai et al. [2]

- Identify and understand the situation. Scrutinise case history, toxidrome, and readings of chemical detectors looking for the nature of the potentially used chemical agent(s).
- Perform life-saving procedures immediately (manage bleeding, set oxygen therapy, maintain airways open), and administer antidotes as indicated[2] [1];
- Conduct wet decontamination (decontamination chain) whenever indicated (Table 28.1);
- Manage victims and evacuate them towards appropriate health structures according to their conditions.

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[2]ANSM. Piratox documents. Available https://www.ansm.sante.fr/Dossiers/Biotox-Piratox-Piratome/Fiches-Piratox-Piratome-de-prise-en-charge-therapeutique/(offset)/4.

Forest Fires

29

Nicolas Cazes

29.1 What You Should Know

Every year, particularly in the South of France, 12,000 hectares burn: forests (coniferous and deciduous), shrublands (maquis and garrigues), or herbaceous lands. Around 90% of forest fires (FF) are human-made and 80% happen at less than 50 m from residential areas.[1] Climatic conditions (dryness, high temperature and wind) encourage the start and spread of FF.

Climate changes have worsened the situation: fire risk has extended to North West of France and to the middle mountains in the South. The risky period will expand from three months (June–August) to 6 months.

Few people are killed directly by FF (20 deaths a year), however, the indirect consequences are substantial (death caused by release of fine particles to the atmosphere [1]).

[1]Ministry of Ecological and Solidary Transition. Forest fires, to prevent and to protect people from them. Media file. June 2020. https://www.ecologie.gouv.fr/sites/default/files/2020.06.19-DP_Feux_foret_compagne_2020_vf.pdf.

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Weather high temperature and that induced by the FF cause exertional heat stroke, burns, smoke inhalation, in addition to traumatic injuries.

29.2 What You Should Understand

FF comprises three successive mechanisms: evaporation of water from combustible materials, emission of flammable gases, and flaming.

For such, three elements are necessary:

- **Combustibles**: vegetation is very good combustible when dry (lower ignition temperature), rich in volatile organic compounds or in resin (characteristics of Mediterranean vegetation);
- **Oxidising agent**: air oxygen;
- **External ignition source**: human-made (accident, carelessness, or malicious) or natural (lightning).

There are three types of fire:

- **Ground fire**: very destructive, slow moving, hard to completely extinct;
- **Surface fire**: fed by low-lying vegetation (detritus), rapid propagation is possible;
- **Crown fire**: tree canopies are affected, crown fire releases a big amount of energy and spreads at very high speed (more than 1,000 meter/h).

Spread of fire is an essential element that depends on:

Natural Factors

- *Wind*: has a major role in the spread of fire as it renovates air oxygen, reduces the angle between flames and the ground, and

transports firebrands ahead of the flames front. Fire intensity and direction are dependent on the speed and direction of wind and on local weather conditions;
- *Vegetation structure and composition* influence its combustibility;
- *Slope steepness*: slopes modify flame angle with the soil and accelerate fire ascending propagation;
- *Exposure*: fires on hot and dry slopes and fires on slopes exposed to wind propagate easier.

Human-Made Actions

- Worsening factors: expansion of forest areas, reduction of partitioning of tree species, lack of forest maintenance, and presence of man in forests;
- Attenuating factors: reducing surface combustibles helps prevent FF.

Effective FF preparedness requires stringent application of the following[2]:

- Prevention via reducing surface fuel around houses and maintenance of forests and firebreaks;
- In fire seasons, monitor forests, prepare fire-fighting means (water sources, duty shifts, etc. (Table 29.1)), disseminate the alert phase, prohibit domestic bonfires, etc.;
- Training and equipment of the responding teams: special gears, fire tankers, Canadair, airplanes, helicopters;

[2]Thierry Hubert, Laurent Serrus, and Fabrice Moronval. Prevention plans of natural risks (PPR): methodological guidelines/Ministry of Ecology and Durable Development, Ministry of Interior Affairs, of Security, and Local Liberties, Ministry of Equipment, Transport, Lodging, Tourism, and of Sea et al. (documented under the direction of Thierry Hubert, Laurent Serrus, and Fabrice Moronval (DPPR). Forest fire risks. Paris: la documentation française, 2002. https://www.ecologie.gouv.fr/sites/default/files/PPR_feux_de_foret_complet_0.pdf.

Table 29.1 Emergency operations rely on human, material, and tactic resources

Human	Equipment	Tactics
Trained staff	Vehicles	Location
Sufficient staff number	Healthcare materials	Work zone
Anticipation of shifts	Monitoring materials	
	Food/water (supplies)	
	Transmission	
	Documentation	

- Firefighting may require plenty of ground-based and aerial-based resources to cover big surfaces and that should be rigorously organised;
- International support might be needed.

Firefighters and rarely the population are exposed to risks. Under the command of the MED, the operational healthcare relief (OHR) team work to support the firefighters (Fig. 29.1).

Exertional heat stroke (EHS) is the most common clinical presentation, mostly mild but can be fatal. Spreadsheets are used to calculate corrected air temperature in order to estimate the required rehydration solutions[3] (Fig. 29.2).

ABC: rapidly lower body temperature: place the patient in a cool place, strip clothes, wet and spray skin with tepid water at 25–30 °C, use fans, and apply ice on neck, armpits, and groins [2].

What You Should Do

- Follow the instruction of FF prevention;
- If a fire is detected, call firefighters (18 or 112), try to put it out using soil, sand, or water (fighting the fire can worsen it sometimes);

[3]Tools to evaluate heat stress at work. IRSST. Calculation of corrected air temperature (CAT). https://www.irsst.qc.ca/prevenir-coup-chaleur-travail/calcul-tac.aspx.

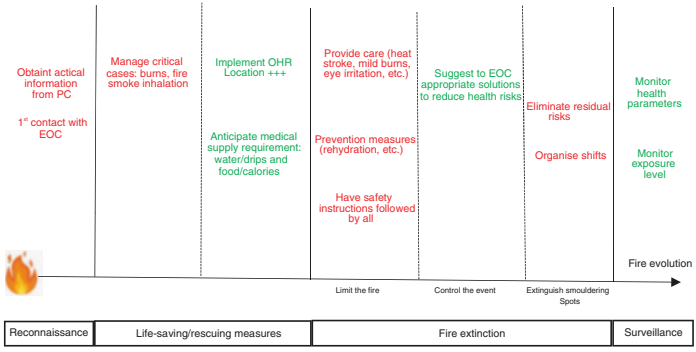

Fig. 29.1 Actions of OHR

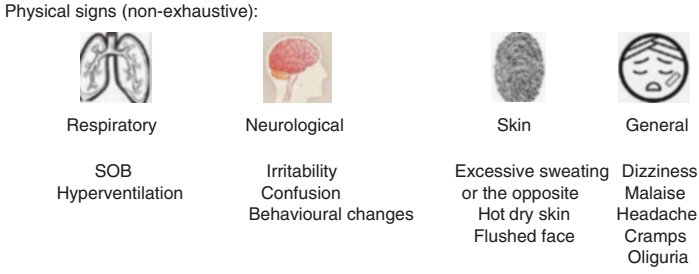

Fig. 29.2 Clinical signs of EHS

- If caught in a FF, stay in the car, if on foot, search a protection screen (rocks, mound of earth), breathe through a wet cloth. Wear cotton-made clothes (not synthetic);
- refrain from any individual action in case the FF is big; rather integrate an organised response plan to fight the fire;
- Know how to diagnose and treat EHS;
- Stay alert to instructions given by the authorities.

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Part IV

Techniques of Disaster Medicine

Principles of Field Medical Care

30

Henri F. Julien

30.1 What You Should Know

In disasters, the missions of the on-scene responding doctor, often in conjunction with a nurse, are numerous: advise the emergency team, recognise, sort out, and provide medical care to the most critical victims.

Given the security and ergonomic conditions, and the need to provide care rapidly whilst ensuring victims' safety, the doctor has to restrain care procedures to what is strictly necessary.

Meanwhile, the doctor should report to the commanding centre and ensure the safety of the other responders.

The doctor's training, conduct, performance, and good integration in the field emergency teams, will facilitate rather than delay their actions.

30.2 What You Should Understand

On scene, victim management can only be envisaged within the framework of an emergency chain articulated with an organised

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care service [1]. The doctor actively participates in victims' release and recovery.

In bad ergonomic conditions coupled with pending risks, the doctor cannot treat all victims simultaneously. For better efficiency, the doctor should:

- Advise the emergency team and monitor first-aid procedures;
- Recognise victims who need the most urgent care [2]: stop bleeding, maintain effective ventilation, manage circulatory failure, prevent hypothermia, and relieve pain;
- Restrict technical procedures to what is strictly necessary, faster, and more effective.

Medical acts should harmoniously integrate the work conducted by all responders so that such acts would not delay rescue, recovery and stretcher transportation of victims.

In wide-scale CBRN-E emergencies, and under certain conditions, the doctor could enter the hot zone [3]:

- Upon using chemical warfare agents, the doctor might be asked to enter the boundary of the hot zone wearing the appropriate PPE in order to help sort out victims and prioritise management of the most critically poisoned. The doctor can participate in the identification of the chemical agent and in determining the immediate ABC to undertake. Simple urgent medical procedure can also be done: administering antidote, maintaining upper airways open;
- In ballistic events, the persistent danger allows only trained medical responders wearing special ballistic protection gears to accompany the Special intervention Force.

According to the situation, the medical intervention should either precede victim release and be part of the ongoing action plan, or come at the final phase.

30.3 What You Should Do

- Entre the scene only if have orders or permission of the operation commander;
- Do not enter alone, better with a nurse or an experienced rescuer. If possible and required, let the nurse take over your work on the first injured whilst you manage another;
- Don an appropriate PPE;
- Having already anticipated and prepared the required emergency equipment, check them before entering; make sure that their size, weight, and composition do not compromise work, and are compatible with the situation;
- Undertake all necessary site protection measures;
- Prevent secondary accidents especially of responders;
- Take notes on the event effects and the condition of victims;
- Inform the operation commander and ask for possible backup;
- Provide essential primary care [4]: better use simple, fast to apply, reliable, and strictly necessary procedures, stop haemorrhage, keep airways open, immobilise and protect fractures and severely damaged tissues, put victims in recovery position, provide thermal protection, and analgesics.
- Predict timeframes and arrangement of stretcher transport and carrying until AMP. Consider attaching medical and monitoring devices and dressings. Attach the victim to the stretcher;
- Ensure good thermal protection to avoid hypothermia;
- Keep tracks of patient care by filling in field medical cards, in paper or electronic versions;
- Prepare or have backup arrival prepared by marking out the access routes;
- In long lasting operations (e.g. search and rescue), do not overestimate your strength, accept to be relieved;
- Reassure victims and show empathy: talk to them even if they do not speak your language, and support the teams who work with you.

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Medical Dispatch in Crises and Disasters

31

Benoît Vivien

31.1 What You Should Know

The causative events of the uncommon health crises (UHC) greatly differ in terms of mechanism, pathophysiological outcomes, kinetics, and required therapeutics (pandemic vs. terroristic attack); nonetheless, they all share common points regarding their natural evolution, and strategies and plans implemented to face them.

Every SAMU has a crisis unit enabling the team to upscale their activity in case of emergency calls overflow or UHC. This unit works in conjunction with the call centre, firefighters' command centre, and other involved services.

Every local SAMU is in charge of managing multi-victim events that happen on the territory it covers. However, once the number of victims exceeds the capacity of a single local SAMU, the coordination of supplementary medical resources will be

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transferred to the corresponding zonal SAMU. There are 12 zones of defence in France, of which seven are in mainland.[1]

ORSEC plan (Organising Response of civil defence services) comprises many specific measures. The most important in terms of emergency and healthcare is NOVI plan (Numerous Victims).[2] ORSAN plan (Organising Response of health system in uncommon health crises) was created by the Ministry of Health in 2014 to organise progressive and coordinated upscaling of health system response facing UHC. It is composed of six components: AMAVI (including AMAVI damage control), MEDICO-PSY, EPI-VAC, CLIMATE, CRN, and BIO.[3]

31.2 What You Should Understand

When a given event generates a big number of victims/patients, the clinical presentations are common for all patients, hence the following:

- The injuries/diseases of the same nature differ only in extension and severity;
- The diagnosis is simplified, and only severity assessment becomes essential for triage, immediate treatment, and hospitalisation.

Once alerted, SAMU will reciprocally exchange information with LFRS and police/gendarmerie in order to organise the health

[1]Zones of defence: https://www.legifrance.gouv.fr/qffichCodeArticle.do?cidTexte=LEGITEXT000006071307&idArticle=LEGIARTI000036598574&dateTexte=20200822.

[2]ORSEC NOVI plan: https://www.interieur.gouv.fr/Archives/Archives-publications/Archives-inforgraphies/Securite-des-biens-et-des-personnes/Mobilisation-de-l-Etat-en-temps-de-crise/Le-plan-NOVI-Nombreuses-Victimes.

[3]ORSAN plan: https://solidarites-sante.gouv.fr/systeme-de-sante-et-medico--social/securite-sanitaire/article/le-dispositif-orsan.

response for each victim, from the field medical chain until hospital admission as dispatched by SAMU.

The objective of SAMU medical dispatch in UHC is to broaden the hospital response area by calling on all suitable and available health facilities.

ORSEC NOVI plan (former red plan) focuses on field management and break up of pre-hospital patients' flow, thus serves as a buffer against hospital saturation and spares them activating hospital contingency plan.

The rule is to anticipate to which hospitals patients could be sent, and to systematically look for available beds, even before having the initial report. On the one hand, this helps alert the contacted hospital facilities, and on the other hand, enables SAMU to have a precise situational analysis of the real-time hospitals capacities.

31.3 What You Should Do

The simplified diagnostics helps the team rapidly initiate a standardised response to patients' influx in terms of field care protocols and to which hospitals patients would be sent.

Installing a SAMU field command post (CP), on the disaster scene, optimises dispatch of patients. This post works in close collaboration with the local/zonal SAMU dispatch centres to look for and centralise information about the available hospital capacities and casualty evacuations.

In multi-site events, a SAMU CP (failing that, a dispatch doctor) on each site is required to manage evacuations to hospitals from each. For such, the coordination is upheld by local (or zonal) SAMU.

Patients' evacuations should be organised at the exit of AMP in order to avoid "chaotic evacuation" towards hospitals not prepared to receive victims, which could lead to unjustified mortalities.

No patient should leave the AMP (or CCP if very critical) without a prior medical decision concerning the evacuation destination.

Dispatching patients to hospitals should take into account the following imperatives:

- The medico-technical platform required for each victim;
- The reception capacity of every hospital, public or private, already pre-alerted by the dispatch centre;
- The available evacuation means, especially air transport;
- Keeping victims of the same family together.

For each victim, three elements guide the selection of the required technical platform, hence the hospital:

- How critical the patient is;
- How much care is needed;
- Expected transportation time (land or air).

Medical reports, inside the medical chain, and between the dispatching medical officer and the hospital departments should be "targeted" and concise as compared to records transmitted by SMUR (the French mobile emergency and resuscitation structure) on a daily basis. Medical reports should be transmitted in groups, in the form of a "package" of victims who will be conveyed together or successively to the same hospital.

A system to track all victims should be setup to document in real time their number, case severity, and the hospital to which they are sent. In France, this tracking is usually performed using the Standardised E-information system (*SINUS*).[4]

The objective is to resume normal daily work as soon as possible, at field pre-hospital level as well as at SAMU dispatch centre level.

[4]SINUS system: https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000030236009&categorieLien=id.

Crush Syndrome

32

Bertrand Prunet
and Emmanuelle Fontaine

32.1 What You Should Know

Crush syndrome, also called Bywater's syndrome or acute traumatic Rhabdomyolyses, is a series of acute systemic complications (hyperkalaemia, early hypovolemic shock, and renal failure) of compartment syndrome with ischemic muscle necrosis.

It occurs secondarily to prolonged and continuous compression of muscle masses with or without compression of vessels or nerves.

32.2 What You Should Understand

The syndrome occurs after 3–4 h of compression; after 8 h, the muscle damage is irreversible.

Removing the compression is the only etiological treatment of crush syndrome.

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However, removing local compression without precautions causes the release of harmful chemicals (especially potassium) into the circulation, which triggers the syndrome and perhaps more serious effects.

For such, symptomatic treatment starts in situ before removing the compression and continues during and after the total release of victim.

The treatment objective is to forestall complications:

- Counteract hyperkalaemia as it threatens life by critical arrhythmias, cardia arrest, and death induced by a bolus dose of potassium;
- Prevent early hypovolemic shock caused by massive plasma extravasation into the compressed muscular mass (third spacing) that might generate cardiac fibrillation. Aggressive and continuous IV fluid resuscitation reduces hypovolemia risk, attenuates hyperkalaemia, and upholds renal perfusion;
- Prevent acute renal failure which threatens the life of the patient on the medium term: first functional (renal hypoperfusion), then organic (acute tubular necrosis due to deposition of myoglobin in the renal tubules) failure.

32.3 What you should do

Onsite Management

Before Removing the Compression

- Consider crush syndrome once there is a prolonged compression of a limb, in particular inferior limbs (namely the thigh and buttock);
- Evaluate the entire situation in coordination with the EOC: associated risks in the surrounding environment, duration of compression, expected duration of extrication, accessibility to the victim;
- Insert a vascular line: a peripheral IV line (well attached), alternative: intra-osseous line;

- Administer isotonic saline: initial drip of 1 L in 20 min to quickly restore effective blood volume and to dilute hyperkalaemia, then secondarily adapt the drip to maintain systolic blood pressure (SBP) at ≥90 mmHg;
- Just before releasing the victim, make sure you have the necessary tools to treat Cardio-Respiratory Arrest (CRA) and life-threatening hyperkalaemia, i.e. defibrillation, adrenaline, and calcium gluconate in case of imminent risk;
- Give analgesics like IV paracetamol and titrated morphine;
- Eventually sedate the victim by ketamine or even general anaesthesia (better use ketamine and Gamma hydroxybutyrate, GHB);
- Thermal protection: avoid hypothermia.

Particular Use of Tourniquet

If there is no bleeding, using tourniquet is so restricted since it often means subsequent amputation. It is considered in case of compression exceeding 8 h, or exceeding 4 h with a persistent shock status despite proper hydration, if there was no IV route at the moment of release, in case of smashed limb, or there was a life-saving amputation. The tourniquet is always applied before the release with special care to note the exact time it was applied. Once installed, its loosening should be carefully and progressively done, with close monitoring of the victim, and with all the equipment necessary to treat hyperkalaemia and cardiac arrest at hand.

Life-saving amputation: *CF.* dedicated spreadsheet.

32.3.1 During and After Removal of the Compression

- Permanent monitoring via electrocardioscope: early cardiac complications incurred by high potassium level are seen as a chronological sequence of ECG changes:
  - Sharp, symmetrical and broad T wave;
  - Prolonged PR interval;

  - Flattening then disappearance of P wave;
  - Widening of QRS complex;
  - Ventricular extrasystole;
  - Then ventricular tachycardia, fibrillation, and asystole
- Alkalinisation using IV sodium bicarbonate at a dose of 1 mEq/kg, i.e. 2 mL/kg of sodium bicarbonate at 4.2% (IV line): helps attenuate hyperkalaemia by pushing potassium intracellularly, and prevents deposition of myoglobin inside renal tubules;
- Before the development of cardiac arrhythmias, calcium salts (gluconate or chloride) are slowly administered IV (e.g. 20–40 mL of 10% calcium gluconate in 3 min);
- Urine dipstrip testing to accordingly adapt amounts of IV drip and alkalinisation solution (measure urine PH);
- Insert a second peripheral IV line: use balanced crystalloid drip to maintain SBP at >90 mmHg. Excreting dark colour urine is a sign of rhabdomyolysis-induced myoglobinuria. Urine alkalinisation and hyperdiuresis improve renal functions by increasing solubility of myoglobin. The objectives are to have a urine output of at least 2 ml/kg/h and to maintain urine PH above 6.5. If there are skin lesions, give antibiotics (2gm of amoxicillin-clavulanic acid) to prevent infections and give anti-tetanus shot as a prophylaxis.

Hospital management:
Victims need a hospital that has a technical platform comprising an ICU and extrarenal blood purification means. The ICU work that follows is symptomatic and focused on renal functions.

Diagnostics:

Blood work should include arterial blood gases and lactate looking for metabolic acidosis and hyperlactatemia, blood electrolytes looking for hyperkalaemia, hyperphosphatemia, and hypocalcaemia, renal function test (plasma urea and creatinine) looking for renal failure, CPK and myoglobin levels to assess rhabdomyolysis. CPK reaches its maximum serum concentration 24–48 h after the trauma and is correlated with the intensity of muscle damage; then it drops at a rate of 35% a day. A CPK serum

concentration of more than 1000 IU/L is a warning sign requiring attention and management. A concentration of >6000 IU/L is a predicting sign of renal failure. Urine investigations include hourly urine output and PH, as well as urine sodium, potassium, urea, creatinine, and myoglobin.

Therapeutics:

The first three days' management aims at maintaining an effective volume and forced alkaline diuresis.

IV drip protocol: basic solution containing a mixture of 500 mL of 5% dextrose and 500 mL of 0.9% isotonic saline solution. For each of the obtained litres, it is possible to add if needed (no recommendation, poor evidence level):

- 50 mL of 20% Mannitol (i.e. 10 g) to maintain forced hyperdiuresis within the objective of reaching a urine output of >2 mL/kg/h, however, the total cumulative dose of mannitol should not exceed 200 g;
- 1 mL/kg of 4.2% semi-molar sodium bicarbonate to maintain urine alkalinisation at >6.5 PH level.

The volume of infused solutions in young adults is 250-500 ml/h, which represents around 6–12 L/day for 2–3 days. If this protocol is applied early, it will help maintain an effective volume, minimise hyperkalaemia, ensure urine alkalinisation, and uphold osmotic diuresis. Loop diuretics are not recommended.

Blood extrarenal purification (BEP) is recommended in renal dysfunctions, with anuria, salt and water retention, and life-threatening electrolytes disturbances.

ICU main objectives [1]**:**

- Urine output ≥2 mL/kg/h
- SBP ≥ 90 mmHg
- Urine PH ≥ 6.5

Potassium level < 6 mmol/L

32.4 Conclusion

In disasters, the main constraints stem from the manoeuvre of releasing the victims and medicating them, the management of overwhelming patient's influx in hospital facilities potentially destroyed or inefficient, and the absence of renal dialysis units.

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Blast

33

Jean-Pierre Carpentier

33.1 What You Should Know

Blast or blast injury includes all pathophysiological phenomena and organic injuries occurring secondarily to the propagation of a shock wave caused by explosion.

The abrupt and sudden release of energy during an explosion:

- Generates high atmospheric pressure that is transmitted into the ambient air resulting in the propagation of a shock wave called Friedlander wave (Fig. 33.1). The latter is characterised by: peak pressure level, maximal pressure variation (ΔP), pressure rise time (Δt), positive pressure duration (t0), and the speed of pressure rise;
- Displaces a big mass of air in the direction of the wave. This blast wind can reach 480 km/h and can: mobilise shrapnel, debris, and objects; throw people against walls or along the ground; result in disintegration and even traumatic amputations (Table 33.1);
- Is coupled with the release of a substantial amount of heat, which depends on the nature of the explosion and the potential presence of inflammable products on scene.

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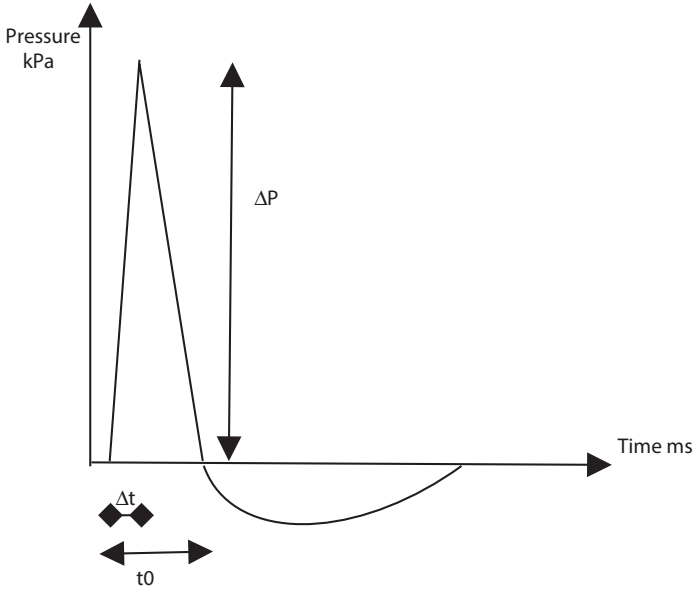

Fig. 33.1 Friedlander wave

Table 33.1 Explosion effects on organisms are multiple

Primary injuries	**The only blast specific injuries**. Induced by propagation of the blast wave inside the human body
Secondary injuries	**Ballistic**: projectiles (shrapnel, nails, bullets, beads, bolts, screws) and/or debris (shattered glass, rubbles, metals, wood splinters) energised by the blast wind
Tertiary injuries	**Traumatic**: victims are propelled against solid objects or along the ground, or have blunt trauma induced by the blast wind. Those are acceleration-deceleration injuries
Quaternary injuries	**Multiple-origin**: burns, smoke inhalation, CO poisoning, burial or crush injuries caused by total or partial collapse of surrounding structures, etc.

The blast wave propagates in air at sound speed (330 m/s) and decays quickly with the cubed root of the distance from the explosion. In water (denser and less compressible), it propagates at 1500 m/s and dampens more slowly (the death radius is three times wider). In solids (dense and incompressible), it is transmitted to the zones in direct contact at a speed of 5000 m/s.

33.2 What You Should Understand

The induced body damage is proportional to the pressure gradient (ΔP) (as of 35 kPa for the eardrums, 175 for the lungs) and the duration of overpressure (t0) which in turn depends on the explosive charge.

In open air, the distance from the explosion is crucial. In a confined environment, the injuries are more severe (near the explosion and the effect of waves reflected on the walls). Ballistic shields and body armours do not protect the lungs; however, noise protection hoods protect the eardrums.

Blast creates a compression followed by abrupt re-expansion of gas volumes (pulmonary alveoli, middle ear) causing pain and rupture.

The blast wind (energised jet) generates compression and shearing forces. Pulmonary blunt injuries seen in deceleration type of blunt chest trauma are close to blast-induced ones.

33.3 What You Should Do

Consider blast injuries if: there is an explosion, particularly in a closed or confined space, the nature of damage in the surrounding structures, high mortality at site, big casualty, multiple trauma, penetrating injuries involving face and forearms, and burns.

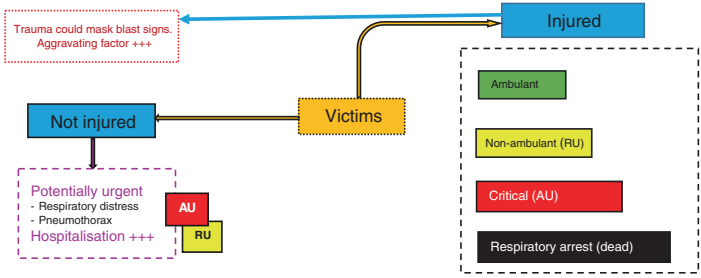

Fig. 33.2 Triage of blast casualty

1. On scene: diagnosis, triage, dispatch (Fig. 33.2).

   Blast is rarely an isolated event. The injuries the victim presents can be of multiple nature (secondary and tertiary) and origin (quaternary). On the explosion site, the objective is:

   - Not to let any victim seemingly uninjured leave as there is the potential risk of complications due to blast lung;
   - Not to consider blast-deafened victims as psychologically impaired;
   - Not to dispatch to orthopaedics-trauma wards a victim with multiple fractures who could develop respiratory distress.

Although eardrums are the most affected organ, a reliable triage cannot rely on detecting eardrum rupture since a normal eardrum does not exclude internal ear injuries.

2. At hospital, there are two outstanding situations to consider according to case severity.
   - **Multiple trauma** (Absolutely urgent)

     In this case making a list of blast injuries is almost impossible and useless. Suspecting blast diagnostics prevails over certainty. The seriousness of the victim condition (suspected blast injury) necessitates in all cases following the usual diagnostic steps in the management of injuries. Time is a determining factor.

     In this situation, respiratory distress is multifactorial. Blast is a single causative element next to the others i.e. aspiration pneumonitis, flail chest, and at later stages, fluid

overload, fat embolism, and acute respiratory distress syndrome. Like with every chest trauma, CT-scan should show what simple chest X-ray and ultrasound fail to reveal e.g. partial pneumothorax.

Interpreting CNS signs is difficult without brain CT-scan. Air emboli are looked for if there are consciousness impairment and/or focal deficit signs. Ophthalmological examination should look for air bubbles in retinal vessels and pale zones in the retina, which can persist for several days.

Diagnostic approach for blast abdomen is similar to the conventional approach for blunt abdominal trauma. If the victim presents acute abdomen or pneumoperitonitis, the diagnostic tool of choice here is laparotomy to look for specific intestinal injuries.

- **Non-serious trauma** (relatively or potentially urgent)

  Is the most common presentation. The victim apparently has no trunk injuries but could have superficial injuries on the exposed part of the body (wounds, skin lesions, penetrating foreign bodies, burns). Diagnosis must be systematic to cover four questions (Fig. 33.3).

- **Specificity of blast management**

  The therapeutic approach of a blast victim does not differ from that employed for trauma victims. Suspecting a blast injury should not delay treatment of associated injuries; however, it should drive attention to potentially life-threatening chest or abdominal presentations. Keep in mind that most blast injuries require no specific treatment and that some therapeutic procedures can deteriorate blast lung.

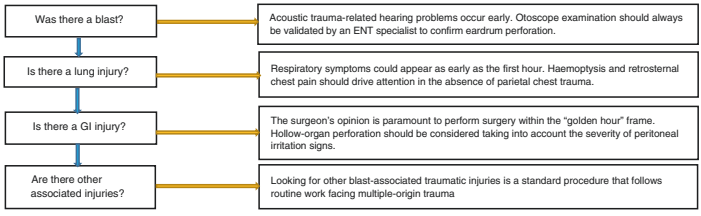

Fig. 33.3 Diagnostic approach at hospital

Ballistic Wounds: Management Principles

34

Stéphane Travers

34.1 What You Should Know

Ballistic wound is defined as the body damage caused by the penetration of an ammunition. The damage is related to the open trauma and to the energy transmitted by the projectile.

It depends on [1]:

- Projectile characteristics (mass, velocity, structure, rotational spin, ability to deform or also to fragment, etc.) (Fig. 34.1);
- The potential presence of intermediate barrier before or after penetrating the body (ballistic protection, bones, etc.)
- The tissue penetrated by missile (vascular, visceral, orthopaedic, neurologic wounds, etc.).

Mapping the path of the missile inside the body and building up wound hypothesis based on the appearance of orifices and their number is too arbitrary to accurately guide the management [2].

Hunting rifles and guns called "less-lethal" can also cause severe trauma, especially at short distances.

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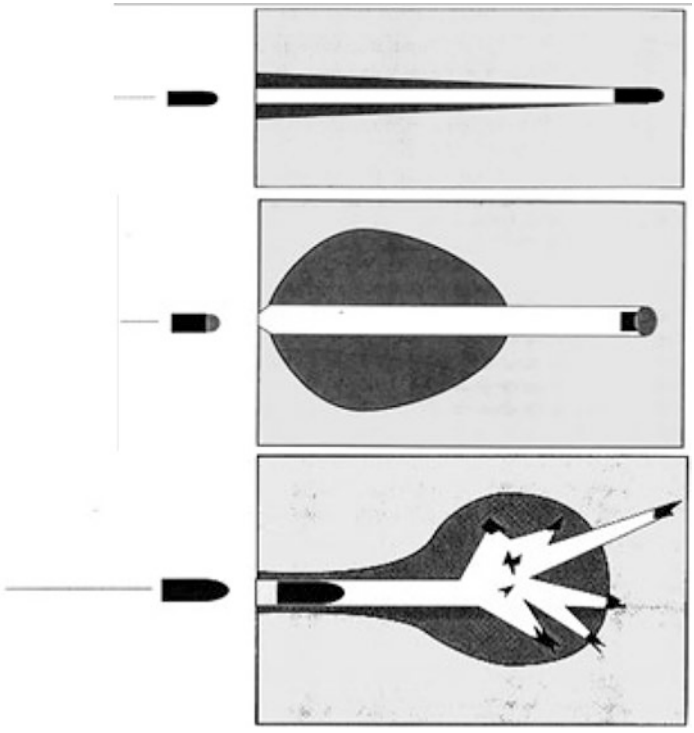

Fig. 34.1 Tissue damage created by the different types of projectiles

34.2 What You Should Understand

Given the early death onset (almost 80% in the first 30 min), the "preventable" nature of some deaths, as well as the huge risk if the zone is not secured force the emergency team to consider medical as well as "tactical" issues.

The medical objectives are:

- **At prehospital level**: look for and manage such preventable death causes (bleeding, airway obstruction, and tension pneumothorax) then immediately evacuate patient(s), whilst maintaining therapeutics (shock management, prevention of

hypothermia, coagulopathy, etc.), to the adapted surgical facilities [3];
- **At hospital**: continue resuscitation, start surgical procedures and perform complete investigations (better include a CT-scan imaging if the patient is stable or stabilised enough).

34.3 What You Should Do on Scene

"SAFE MARCHE RYAN" concept can be used to guide and prioritise prehospital actions, in particular in mass casualty and/or when the threat persists or is uncertain [2, 4].

S: **Security**→Protect yourself, help (without exposing yourself) the injured find shelter;
A: **Analyse the situation**→What is the threat? How will it evolve? Any retreat zones? Where are the officers in charge of each team (EOC, MED, COPG)? What are the inter-service communication means (radio channels, direct contact, etc.)?;
F: **Free from danger—Law enforcement**→What are the safety instructions? What are the common manoeuvres to extract and protect victims and/or how can emergency teams access scene (jointly defined by first EOC, first MED, and first COPG, then adjusted according to the situation development)?;
E: **Evaluate**→Sort and tag victims to prioritise management and evacuation of the most critical;
M: **Massive bleeding**→Carefully look for and immediately stop all bleedings easy to reach by prehospital tools (tactical tourniquet, pneumatic tourniquet, haemostatic packing, compression, junctional tourniquet, scalp suture, pelvic belt, etc.);
A: **Upper Airways**→Maintain upper airways open. Use simple measures (Guedel cannula, recovery position, etc.) or elaborated like intubation or insertion of subglottic catheter whenever needed;
R: **Respiratory/Thorax**→Make sure there is no tension pneumothorax, treat with exsufflation or thoracostomy (chest tube); oxygen therapy for respiratory distress;

C: Shock→In case of haemorrhagic shock, maintain systolic blood pressure above 80–90 mmHg using blood products (better use whole blood if available, freeze dried plasma and/or packed red blood cells otherwise), failing that, small volume resuscitation using crystalloids; administer 1 g of tranexamic acid; administer vasopressors if needed;

H: Hypothermia→Prevent hypothermia by all means (shelter, isothermal blankets or heat sheets, warm the infused fluids, etc.); measure the temperature;

E: Evacuation→Immediately evacuate victims starting with those whose bleeding cannot be stopped;

R: Re-evaluation→Fill in a field medical card for every victim, monitor, and re-evaluate the victim throughout the management;

Y: eYes, ENT lesions→Look for and treat ocular and ENT injuries, and functional impairment;

A: Analgesics→Evaluate and treat pain, immobilisation;

N: cleaN→Topical care, antibio-prophylaxis by 2 g of Amoxicillin-Clavulanate (or Dalacin + Gentamycin if allergic to penicillin).

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Damage Control

35

Luc Ronchi

35.1 What You Should Know

Damage control is a military-derived tactics [1] based on field experience. Its objective is to ensure in disastrous conditions (imbalance between health resources and victim healthcare needs in terroristic attacks especially mass shooting and explosion) the best possible compromise between individual medical care and the collective interest of the concerned population.

Every step of patient management should reconcile the need for urgent treatment (survival in the initial phase) and the necessity to save time in order to treat as many victims as possible.

Damage control was initially used in war surgery (early management of life-threatening injuries is covered in the initial phase, completed by secondary measures until stabilisation), and then extended to intra-hospital ICU and prehospital medicine.

One can summarise it by "the right (no more, no less) care at the right time" or as well "leave well enough alone".

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35.2 What You Should Understand

The initial phase mortality is due to the triad of respiratory distress, uncontrolled haemorrhage, and secondary metabolic acidosis.

Hypothermia is an aggravating factor that develops rapidly if not prevented by prophylactic measures.

Thus, the initial treatment is to manage respiratory distress (exsufflation for tension pneumothorax, intubation or cricothyroidotomy in case of major facial wounds or blunt trauma) and to control massive external haemorrhage (tactical tourniquet on the bleeding limb, haemostatic or compression packing, wound clamps).

The concept of permissive hypotension is perfectly suited to such situations. Its objective is to restore adequate tissue perfusion in vital organs (heart, brain, liver, kidneys) by correcting hypovolemia whilst avoiding excessive IV fluid infusion, which causes further blood loss or rebleeding.

Mean blood pressure (mBP) is a determining parameter for IV fluid therapy. In adults, the targeted mBP to achieve is 65 mmHg, reaching 80 mmHg if there is brain injury with GCS < 9. In children of more than two years, it is 55 mmHg (45 mmHg if under two years), with additional 10 mmHg if associated with major brain injury [2].

Fluid therapy starts initially with isotonic saline solutions (glucose solutions are prohibited) relayed by hydroxyethylamide (HEA) upon exceeding 1500 mL of saline in adults. HEA is limited to 30 $mL.kg^{-1}$ in the first 24 h and requires, in France, prescriber's approval (cf. chapter of "IV fluid therapy").

Using hypertonic saline solution (7.5%) helps reduce the volume of replacement fluid. However, defining its therapeutic protocol is still in process [3].

Using noradrenalin for haemodynamic control [2, 4] can be useful to maintain optimal blood pressure and avoid excessive rise in BP.

Tranexamic acid has been shown useful in preventing secondary haemostasis complications. It should be injected early (less than 3 h after trauma) at a dose of 1 g (10 mg.kg^{-1} in children in 30 min) intravenously.

Field blood transfusion necessitates major logistic considerations and should be discussed in terms of benefits vs. constraints, and overall, it should not uselessly delay evacuation of victims to the destined hospital facilities.

There are reference procedures (SAFE MARCHE RYAN, START algorithm [Jump-START for children], Tactical Combat Casualty Care) to usher assessment and action plans in such circumstances.

35.3 What You Should Do

- Do not expose yourself or your team to uncontrolled risk (shooting, hostage taking, etc.);
- For every victim, provide the medical care most adapted to their injuries and situational condition (life-saving measures, haemodynamic control, without omitting hypothermia prevention [thermal blanket] and tranexamic acid injection);
- Report to the medical emergency director throughout the entire management process to prepare evacuation towards adapted hospital facilities (at least to perform surgical haemostasis and ICU care);
- Neglect neither pain management nor identification of treated victims;
- Regularly exercise with your teams (Fig. 35.1).

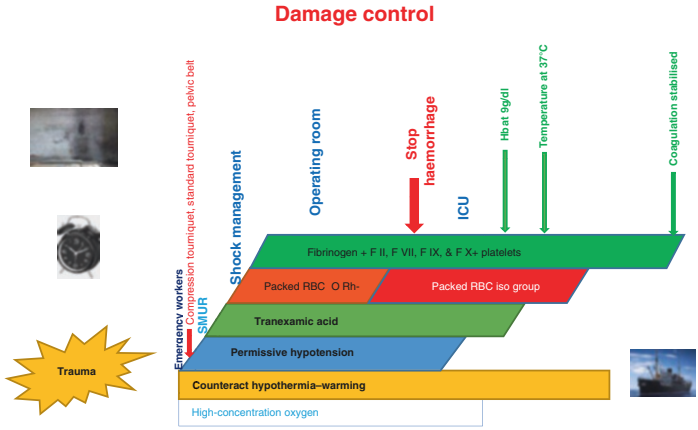

Fig. 35.1 Algorithm showing the major management steps in Damage Control

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Fluid Therapy in Disasters

36

Luc Ronchi

36.1 What You Should Know

Fluid replacement (administering fluids in order to treat relative or absolute hypovolemia) is a common measure of disaster mitigation irrespective of the circumstances.

Fluid therapy aims at restoring blood circulation to maintain perfusion of vital organs (heart, brain, liver, and kidneys) rather than establishing, by any means, a normal blood pressure. Permissive hypotension [1] is a concept where mBP is kept at a threshold level that varies in adults between 65 mmHg if there is no brain trauma and 80 mmHg if there is (GCS < 9).

In children, the objective is to keep mBP at 55 mmHg if aged more than two years, and at 45 mmHg if less than two years, with additional 10 mmHg if there is serious brain trauma [2].

Assessing the volume of intra-abdominal bleeding can be made using FAST ultrasound technique whenever available provided that a qualified caregiver interprets the results.

Choosing which fluid solution to give should not delay the setup of the infusion drip.

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There are many categories of infusion fluids: crystalloids, albumin and plasma, hydroxyethylamide, modified fluid gelatines, and dextran.

Adding vasopressor by continuous IV or IO (intraosseous) line might be useful, in particular within the context of damage control.

36.2 What You Should Understand

Apart from exceptional conditions (acute infantile diarrhoea, massive influx of burn victims), fluid replacement requires implementing a reliable IV line of a calibre adjusted to the patient's size.

The usually used routes are IV via short peripheral catheter and IO.

Central IV lines and intra-arterial lines are excluded. Using longitudinal sinus route in infants is no longer indicated.

Fluid replacement objective is to avoid overloading since its drawbacks (on brain, coagulation, and increasing blood loss before surgical haemostasis) are well proven now [3].

The choice of infusion solutions depends on the circumstances and the pathophysiology of the internal environment dysregulation.

Glucose-containing infusions with or without electrolytes are not useful in such situations (risk of brain oedema). Isotonic saline solutions (0.9%), hypertonic saline solution (7.2%), Ringer-Lactate solution are indicated in the initial fluid replacement phase.

Hydroxyethyl starch solution (HEA 130) is used as a second line fluid therapy when there is considerable blood loss, but should not exceed the daily dose of 30 $mL.kg^{-1}$ (risk of renal injury otherwise).

Albumin is not indicated in the field management of hypovolemia i.e. in the first hours.

Freeze dried plasma, currently developed by the French army health services, will represent in the future an important element to implement in the therapeutic process.

Blood transfusion is an uncommon procedure on scene due to the substantial logistic and safety issues it requires.

Victims are transported on stretchers in horizontal position rather than inclined (proclive position) to avoid any risk of collapse due to defusing.

36.3 What You Should Do

- Estimate, at best, the blood loss volume (circumstances, observed injuries, clinical examination findings);
- Undertake basic measures that can minimise or stop bleeding (tactical tourniquet, compressive dressing, local coagulants);
- Care not to neglect paradoxical bradycardia, which is a sign of bad prognosis here;
- Insert a large-bore peripheral IV line and firmly attach it (IO lines are secondarily indicated in adults, and might be the first route indicated in children);
- Start fluid replacement by crystalloids and monitor their efficacy by checking basic clinical signs (pulse, BP, and consciousness)
- Do not over infuse and know when to switch to HEA if necessary (ANSM, the French authority for drug safety, has required since April 16th 2019, as part of a controlled-access programme, that doctors who prescribe HEA are certified) [4];
- Use norepinephrine (which is a recommended vasopressor) when fluid replacement alone fails to restore haemodynamic stability before transportation;
- Closely monitor victims using simple clinical signs (pulse, non-invasive measurement of BP, consciousness, skin colour).

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Procedural Sedation and Analgesia

37

Luc Ronchi

37.1 What You Should Know

The objective of procedural sedation and analgesia (PSA) is to help the patient to tolerate short painful procedures while preserving spontaneous breathing and upper airways protective reflexes.

The conditions in disasters (many victims, shortage of healthcare staff, uncertain availability of monitoring devices) increase the sedation or analgesia-related risks as compared with intrahospital practice.

Those difficult conditions are not an excuse to intentionally violate the safety rules recommended for the good medical practice

Benefit/risk ratio of these techniques should be assessed case-by-case taking into account the circumstances and the planned procedure (extraction from hazardous environment, life-saving amputation, reduction of fractures or dislocations, etc.).

The victim's past medical history, if known, may help adapt the intended procedure.

A full stomach brings along the risk of inhaling gastric contents, thus should be taken into account

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37.2 What You Should Understand

The risks related to PSA are triple: allergic, haemodynamic and respiratory

- Allergy is difficult if not impossible to screen in a reliable way (language barrier, limited accessibility to victim, and questionable reliability of the dialogue with the patient);
- Haemodynamic complication is basically related to the sudden decompensation (vasoplegia, negative inotropic effect of the employed drug) of latent hypovolemia;
- Respiratory complication is related to the central depressive effect of the drug (propofol, morphine) and to its muscle relaxant effect (Propofol, benzodiazepine) that causes upper airway obstruction;
- Drug combination enhances the risks inherent to each molecule.

Effective preparedness for the occurrence of one of these complications requires the immediate on-scene presence of medical staff and materials necessary for their treatment:

- Medical supplies should include, at least, cardiac monitor/defibrillator, aspiration and breathing support kits (bag, valve, mask), oxygen supply device, a pulse oximeter, a non-invasive blood pressure measurement device;
- Close monitoring of the victim is necessary and should be prolonged beyond the end of the performed medical act (secondary release of morphine causes delayed apnoea);
- Monitoring is clinical (pulse, blood pressure, skin colour, respiratory rate) and instrumental (ECG tracing, oxygenated haemoglobin saturation (O_2 sat));
- Monitoring expired CO_2 provides additional safety via the early detection of respiratory rate alteration, however, its implementation in disasters is currently challenging.

The available molecules in use are gas (MEOPA: an equimolar mixture of oxygen and nitrogen protoxide) and injectable medicines (ketamine, morphine, midazolam, propofol). The injectable drugs are systematically titrated in a way to obtain the desired effect and to monitor the occurrence of their adverse effects. Their duration of action is variable and poorly predictable.

Short-acting curare (succinylcholine) is used as a general anaesthetic and has its own applications. It has no place in procedural sedation and analgesia.

37.3 What You Should Do [1–3]

- Define, after thorough clinical examination, a strategy adapted to the concerned victim taking into account the situational condition, the immediate future (evacuation condition), available human and material resources to manage possible complications;
- Establish a safe environment (cf. supra) and start the procedures using the dosages below (Table 37.1):

Table 37.1 Medicines used for PSA, their routes of administration, dosages and contraindications in adults and children

Molecule	Contra-indications	Adult	Child
MEOPA	Major facial trauma Pneumothorax	Inhalation	Inhalation
Ketamine	Head trauma with impaired consciousness	IV: increment of 0.1–0.2 $mg.kg^{-1}$ IM: 2 $mg.kg^{-1}$	IV: increment of 0.5 $mg.kg^{-1}$ IM: 3 $mg.kg^{-1}$
Midazolam		IV: increment of 1 mg	IV: increment of 0.05 $mg.kg^{-1}$
Morphine	Infant <6 months	0.05 $mg.kg^{-1}$ IV then iterated bolus of 1 mg	0.05 $mg.kg^{-1}$ IV then iterated 0.01 $mg.kg^{-1}$ IV
Propofol	Children <3 years	0.5 $mg.kg^{-1}$ IV, repeatable	0.3 $mg.kg^{-1}$ IV, repeatable

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Search and Rescue (SAR)

38

Emmanuelle Fontaine
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38.1 What You Should Know

Search and rescue [1] are operations undertaken by rescuers and first-aiders and include **reconnaissance**, **rescue of victims**, and **cordoning** of collapsed or about to collapse sites (earthquakes, building collapse, landslide, explosion of a gas pocket, etc.).

Coordinating work with SAR teams requires doctors to take part in exercising and preparedness steps.

SAR teams come from:

- Sapper-firefighter territorial or military units;
- Civil defence-approved associations;
- NGOs.

For missions abroad, and to integrate international teams, UNO requires INSARAG [2] certification (International Search And Rescue Advisory Group) to guarantee respecting its international standards.

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Scene Characteristics [3]:

- Hostile and unstable environment with high evolving risk;
- Need to acquire specific skills: anticipation, resilience, and high operational commitment;
- Specific materials and special procedures: localising victims, hydraulic shoring, trench sheeting, lighting, labelling, listening and visualisation (geo-stereophone, rotating infrared camera);
- Field implementation of specific manoeuvres like necrotomy: release of survivors trapped by dead bodies;
- Release of victims: shoring, piercing, lifting, pulling out, and using rescue stretcher in coordination with the doctor.

38.2 What You Should Understand

SAR operations include:

- **Reconnaissance** of the intervention zone;
- **Zoning**: install security perimeters of the intervention zone;
- **Sectoring**: distribution of units in the same zone or worksites;
- **Emergency operations**: search and localising victims, extrication, clearance, field medical and emergency management, and evacuation after extraction.
- **Labelling**: to avoid overlaps between sectors

Every stage requires technical skills, materials (progression, extraction), and adapted procedures.

On-scene Medical Management Starts by

- Rescue phase (see if many victims, begin by triage like START ABC);
- Medical phase: stabilisation and extraction, then evacuation by local EMTs[1];

[1]EMT: Emergency medical team: WHO accredited, engaged by UNO or governments to provide medical care to victims.

Features of Doctor-Nurse Pair Working on SAR Scene

- **Having the knowledge and technical skills required in disaster and emergency medicine**;
- **Sound body and mind**: having no claustrophobia or fear from working in hostile and harsh environments;
- **Tolerate frustrating conditions**: forced to abandon an ongoing technical procedure because of threatening danger/high probability of victim's death when procedures are long;
- **Resilience**: react according to calculation of risk-benefit for the victims. Healthcare should be rational, restricted to the minimum, the simplest, and the most effective;
- **Ability to work in stringent conditions with multidisciplinary teams**.

38.3 What You Should Do

- **Have good communication and adaptation to work with SAR teams**: act in synergy with SAR members to ensure victim safety, access, and extraction;
- **Do not impose anything that could jeopardise safety** of SAR team members or yours;
- **Have good knowledge about extraction techniques as well as SAR procedures**: hence the importance of exercising and training with SAR teams in advance in order to acquire their management skills;
- **Prepare mission in advance with the necessary materials**, an important step for fast operational response;
- All buried victims are **seriously traumatised, with hypovolemia and suspected crush syndrome**. The objective is damage control. Monitor airways, insert a peripheral IV or IO line, and start monitoring vital parameters as early as possible;
- **Be efficient and timely in reaction** as soon as you can reach the victim;
- **Be on your guard** if there is need for anaesthesia-analgesia whilst maintaining haemodynamic and respiratory functions stable, then use Ketamine as the drug of choice;

- As part of the job, doctors participate in keeping their team in good health, ensuring their safety, and provide them with care if need be, on scene and in camps (hygiene, food); similarly for dogs if there is no veterinary.

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Life-Saving Amputation

39

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39.1 What You Should Know

Albeit a drastic and irreversible medical act, life-saving amputation is mandatory in uncommon health crises (earthquake with many victims in very terrible shape). It is rarely performed, however, requires **codified and multi-disciplinary decision-making process**. It is part of damage control, and aims at saving the victim's life following the concept of "limb or life". It can be practised on scene by an emergency doctor if there is no surgeon.

Extrication Conditions

- Natural disasters: the victim's limb is trapped, in a space large enough to maintain life, by a structure accessible to rescuers but beyond their technical capacities to remove it.
- Building collapse, traffic accident, or work accidents

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The extrication duration is variable, the access to the victim is restricted, and reaching airways and installing peripheral IV or IO lines are often complicated.

Life-saving amputation is a necessity amputation (different from elective amputation) done by a non-surgeon, forced to act. The decision-making is difficult and should not be delayed a lot as that would deteriorate victim's clinical condition. It is paramount to ask SAR team specialists for advice beforehand. The operation is done after applying arterial tourniquet distally, preferably with safe sedation, and with materials suitable for fieldwork (poor ergonomics and constrained space).

39.2 What You Should Understand

The emergency or anaesthesia-resuscitation doctor is often alone: no surgeon, difficult situation, victim in poor condition, and facing ethical and moral issues.

Managing vital distress and stabilising the patient are the priority.

Preparatory Phase: Decision-Making

The decision-making process is multi-disciplinary and shared by the medical team, the specialised team of SAR (impossible to extricate), and the victim (if possible). The victim's general status must be compatible with amputation. Most often, the entangled part of the limb is crushed and out of reach.

Other Factors to Consider

- Level of care available at receiving local facilities and their capacity to manage a post-amputation case and perhaps perform complementary surgery after extrication;
- The qualification of the physician who will perform the amputation;
- Availability and preparation of equipment (Gigli wire saw to use in confined spaces or handsaw), and sedatives-analgesics to be used during and post-amputation.

Internationally, LEMA [1] and local authorities' prior approval is mandatory. In addition to the resulting disability, physical and psychological trauma, amputation might be seen in some counties as pejorative (crime) and that should be taken into account.

Indications of life-saving amputation are:

- A critical case necessitating immediate disentanglement of the patient to facilitate resuscitation (life-threatening condition on the short-term);
- Environment presenting impending danger for the victim and/or the rescue teams;
- A situation of entanglement, which after analysis, presents no other possible solution to extricate the victim.

Mangled Extremity Severity Score (MESS) [2] is difficult to assess or even unrealistic in uncommon health crises.

39.3 What You Should Do

Preparation for Amputation Procedure

- Anticipate work ergonomics: site lighting, preparation of all intervention steps. Brief the teams on the difficulty to work in a confined space. Good communication and coordination between the various responding teams warrant efficacy. Anticipate how to release the victim before the amputation;
- Use clear verbal communication to reassure the victim, show empathy, and seek approval;
- Set a venous line, if possible in the superior vena cava draining area (peripheral IV or IO) [3];
- Monitor breathing, heart beats, and if possible non-invasive BP and SpO_2;
- Cleanse the skin around the intended surgical site, heavily disinfect with antiseptics; add broad-spectrum antibiotics after checking the patient's status and the medical action plan;

- Preferring safe sedation is wise (e.g. for adult: 1–2 mg/kg of IV ketamine given after 1 mg of atropine and 2–3 mg of midazolam IV) and depends on the possible administration routes;
- Install an effective arterial tourniquet as distal as possible to achieve bloodless section and then boost it by another temporary tourniquet

Amputation

- Should be performed as distally [4] and conservative as possible [5] in the most sterile conditions. Special attention should be paid to infections related to instruments, fluids, and bone fragments;
- Proper muscle and bone section should be performed as distally and simply as possible. Dressing is made after heavy disinfection by antiseptics;
- Keep tourniquet in situ. If necessary, stop further bleeding by vascular ligature or a second tourniquet;
- Heavily disinfect and dress the stump.

Post-amputation

- Properly control bleedings and maintain analgesia;
- Make a note on the patient's evacuation card as to the time and the procedures types;
- A complementary surgical examination will be done later in the operating room;
- Internationally: if the patient is placed under the care of local emergency teams (oral and written transmissions), you must inform LEMA and the on-site operation coordination centre.

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Disaster Situations and Psychological Impact

40

Humbert Boisseaux

40.1 What You Should Know

The sudden onset and devastating effects of disasters have psychological consequences difficult to assess at the time they occur. However, they need an immediate and effective response.

All people present and directly affected, their relatives, as well as the responders who come to rescue them are psychologically impacted, more or less, by the event. The adaptive capacity of each is tested and the results are not the same for all. It is particularly sensitive when it comes to a relative or a child's injury or death.

Not all people necessarily have capacities to go through the crisis unassisted. Beyond the immediate needs, the long-term outcome of these people is at stake. An early management will certainly improve the prognosis.

An effective action plan helps put those people on the right healthcare path, which is by nature specific. The medico-

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psychological emergency care unit MPEU, articulated with local SAMU, should be able to organise care of these victims [1, 2].[1]

40.2 What You Should Understand

Importance to Have a Safe Place

The immediate impact of a disaster on human is related to its sudden onset as well as the chaos it creates. The disturbed human interactions, distracted thinking, and the inappropriate behaviours facing the actual situation call for help.

If the emergency team actions and the implanted healthcare measures contribute to creating a sense of security, the necessary psychological work cannot be sustained without a reassuring presence of caregivers capable of reintroducing structuring verbal communications.

Danger of Dysfunctional Behaviours

Every disaster generates a unique situation that disrupts daily biopsychological functions of people. They react on their own following a mental process that is never univocal or truly predictable.

Facing such situations, some people manage to naturally mobilise their operative adaptive capacities, which is not the case for all. The range of the encountered behaviours is extremely wide, from disrupting disordered agitation that is difficult to control to a state of complete stupor. These behavioural disorders are symptoms of psychological suffering often impossible to formulate and fraught with danger.

Complex Approach to Confused People

Approaching people directly affected by the disaster can be complicated for responders not familiarised with such situations.

In these circumstances, irrespective of the responders, healthcare professionals or not, the immediate response, warranted by

[1]Decree n° 2016-1327 of sixth October 2016 related to organising health system response (ORSAN plan) and that of national network of medico-psychological units to manage uncommon health crises.

the dangerous inappropriate, individual or collective, behaviour, should be fast, simple, and effective.

The qualities of the attending person, as attentive, firm, directive, and has capacity to formulate, without inappropriate discussions, the reasons, the objectives, and the proposed means of help remain the best way to obtaining patient's compliance.

Characteristic Clinical Expressions

In the acute phase, the clinical expression used to designate the presented disorder does not help to identify the underlying psychopathological process nor to state a reliable prognosis of the outcome.

Essentially, the absence of a positive response to a calming and reorganising attendee, to effective "defusing [3]" measures, justifies, in the field, the action of specialists. The persistence of a dissociative status, which evidences the harmful impact, and sometimes associated with an underlying mental disease, necessitates initiating special therapeutic measures.

Usefulness of Specific Measures, MPEU[2]

Implementing a medico-psychological emergency post helps manage these cases. This post is deployed as close as possible to the disaster site and is staffed by mental healthcare professionals. The primary diagnostic approach should help them designate the proper management line of each victim.

There are diverse specific techniques, early or deferred, individual or collective, such as "debriefing" that can be set up by trained health professionals, when they are indicated or possible. They should enable, according to the temporality of each subject, to assess the traumatic impact of the event along with the quality of individual psychic resources. This evaluation will aid in engaging adapted therapeutics. Unlike physically injured victims, a few of them will be sent to hospitals. The most important is the articulation with out-of-hospital medical care adapted to the nature and temporality of post-trauma psychological disorders, which will allow, on the long term, to ensure the continuity of necessary follow up.

[2]DGS/VSS instruction 2/2017/7 of sixth January 2017 related to organising management of medico-psychological emergencies.

Specific Attention to the Physically Injured

Although prehospital management of the physically injured had by itself a reassuring effect, it should not be limited to medico-technical approach.

The psychological trauma those physically injured had requires human help via verbal communication that is both supportive and informative. Beyond this, assessment of consequences of the encountered trauma, its psychological effects, and the need for medico-psychological care to overcome it, is paramount.

40.3 What You Should Do

- Contribute to the creation of a safe place those traumatised need to restore effective psychic functions;
- Know how to recognise psychologically impacted victims, in particular, those exhibiting behavioural disorders in order to engage their management without delay;
- Know how to initiate MPEU care, even alone, to perform real evaluation and specialised management of those whose health status is worrying;
- As for the physically injured, and despite a prehospital management that represents by itself a reassuring act, it should not be limited to the medico-technical approach. It should be coupled with a supportive and attentive human assistance;
- Note all observations and measures performed on the emergency cards of victims as you do in medical files.

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Reception of CoVID-19 Patients at the ER

41

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41.1 What You Should Know

CoVID-19 is a disease caused by a new coronavirus that was identified in China in January 2020 as SARS-CoV-2. It replicates very rapidly, highly contagious, droplet-borne where infection happens within 3–5 (up to 14) days of incubation, and may cause major pauci-symptomatic hypoxia and atypical ARDS.

Diagnosis relies on molecular test, RT-PCR and on low-dose thoracic CT-scan.

At day 7–10 of CoVID-19, the body may develop an exacerbated inflammatory reaction with acute respiratory failure (ARF), severe pauci-symptomatic hypoxia, and atypical ARDS.

Owing to the absence of effective antiviral therapy, the treatment counts on ventilation management (simple or high-flow O_2 therapy and invasive ventilation).

The national strategy of prevention and fight against the epidemic copies its plan from Flu pandemic plan [1, 2] already

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described in the guidelines of management of uncommon health crises [3].

41.2 What You Should Understand

At ER Level

- Apply adequate isolation measures to avoid spread and cross-contamination, particularly during intubation or ventilation manoeuvres;
- Precociously identify triage levels and their corresponding healthcare lines;
- Manage downstream flow of the ER by adjusting the hospitalisation capacities of the medical wards and specialised units;
- Make sure that patients with critical respiratory functions are well managed and referred [ICU, clinical observation units (Obs)].

At Hospital Level Coordinated by HCU (Hospital Crises Unit)

- Call for additional human and material resources (oxygen supply, scopes, self-propelled syringes, ventilators, intubation materials, and anaesthetics);
- Anticipate needs for ICU beds, create new beds by transforming those of Obs or recovery units;
- Coordinate referral of ICU patients and make their transfer more fluid in order to have a number of beds adapted to patient's flow.

41.3 What You Should Do

Health Establishment

- Activate the epidemic component, ORSAN EPI-CLIM, of the contingency plan: it should anticipate increasing the number of

ICU beds, identify pre-cohorting zones (to isolate patients waiting to know their viral diagnosis), dedicated hospital units, and a specific cohorting cycle inside the hospital;
- Deploy PPE according to the risk level (staff training must have been anticipated), impose strict donning/stripping procedures, and a maximal protection at the area of triage and reception.

ER
- Establish a specific triage area at the entrance of ER connected to two distinct, entirely separated circuits of CoVID +ve and −ve, and define diagnostic and patients' referral algorithms [4] (Fig. 41.1);
- Define algorithm for ventilation strategy of ARF based on recommendations in order to optimise hospitalisation capacity (ICU, Obs) [5];
- Adjust the ARF management procedures: protection of staff, using video-laryngoscope, closed aspiration circuits, high-quality antiviral filter (e.g. HEPA) at expiratory ports of ventilators

At Territorial Level, Coordinated by HCU and SAMU
- Define with ICU staff the selection criteria authorising the transfer of patients from one ICU to other distant ones accord-

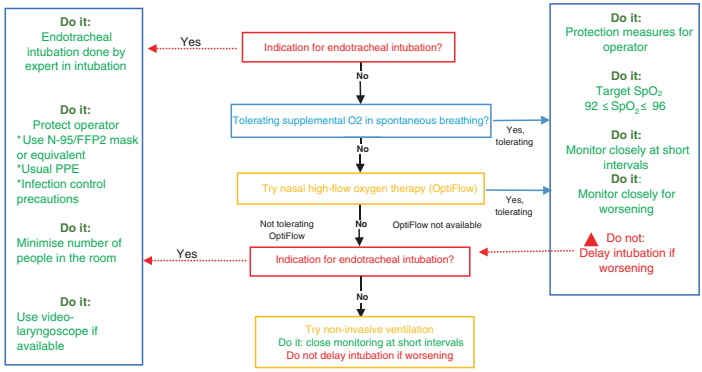

Fig. 41.1 Example of algorithm for ventilation strategy of ARF [6]

Table 41.1 Patients' selection criteria authorising their transfer between ICUs

Intubated patient—ventilated, confirmed CoVID +ve
PaO_2/FIO_2 ratio > 120 mmHg
Haemodynamically stable (low doses of noradrenalin)
Stable respiratory function (no prone positioning over the past 24 h)
Low risk of rapid worsening (either patient at initial phase of ICU management, or 4–5 days after the acute phase)
Weight < 140 kg (110 kg if transfer by TVG train or airplane)

ing to the available transport means (plane, HéliSMUR,[1] TGV train, etc.) (Table 41.1)

- Set up a coordination unit of SAMU-call centre 15: territorial management of ICU beds and logistics of transfer of patients;
- To be articulated with the regional coordination upheld by RHA (regional health agency, *ARS* in French), Zonal SAMU, and the zonal operational centre in charge of identifying extra-regional receiving structures and the adapted transfer means.

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[1] HéliSMUR: special SMUR-owned helicopter.

Mass Casualty Decontamination

42

Catherine Bertrand, Éric Lecarpentier, and Matthieu Heidet

42.1 What You Should Know

The main objective of mitigating a CBRN-E[1,2,3] event is to manage potentially big casualty, exposed to one or several risks including nuclear and/or radiological (RN), biological (B), chemical (C), and explosion (E). The occurrence of CBRN-E events can be of industrial accident origin or terroristic.

[1]Newsletter N° 700/SGDSN/PSE/PSN of 2 October 2018 + annex.

[2]Newsletter N° 800/SGDSN/PSE/PPS of 18 February 2011 + annex.

[3]Inter-ministerial newsletter n° 007/SGDSN/PSE/PPS of 8 October 2009 related to inter-ministerial intervention procedure facing threats or execution of terroristic nuclear, radiological, biological or chemical attack (CBRN).

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CBRN-E victims have complex presentation: injured, and/or burnt, and/or blast-injured, and/or poisoned, and/or contaminated. Moreover, their management is complicated by the risk of transferring contamination or contagious agents.

On the event site, there are many objectives to achieve under the general authority of the operations director (DO) and the legal authorities (public prosecutor), after verification of specific subnational authorities. Civil defence operations are the responsibility of the emergency operation commander (EOC), those of public security are the responsibility of the police and gendarmerie operation commander (COPG), those of legal security are of the judicial police operation commander (COJP), and those of emergency care are of medical emergency director (MED).

At health establishments level (HE), incorporating ORSAN AMAVI, NRC, and REB in the contingency plan should prepare the ground for the unexpected arrival of injured, poisoned, contaminated, and infected victims, including children and disabled, according to predetermined flows.

42.2 What You Should Understand

RN risks can immediately be detected. RN victims are asymptomatic, ambulant, and externally contaminated, thus should protect their airways and refrain from drinking, eating, or smoking before complete stripping and showering.

Chemical warfare agents are clinically detectable at early stages except for mustard gas. Identifying the chemical substance takes two hours, at least, after the initial exposure.

Nerve and blistering agents are persistent hazards that require deep shower-based decontamination to complement the emergency dry decontamination.

Triage helps distinguish victims involved but not physically injured nor carrying traces of contamination, who will be monitored at a given point awaiting valid information on the causative

agent. Other ambulant or non-ambulant symptomatic victims will be classified as AU and RU.

Decontamination of victims imposes wearing proper PPE and applying the decontamination corridor walk-through technique.

The techniques used for mass casualty decontamination i.e. stripping and walking under deluge of non-heated water, have cultural and physiological (hypothermia) limitation, as well as doubted efficacy.

42.3 What You Should Do

- Establish zones on-site and at hospital entrance;
- Give clear safety instructions at zones of collection (keep in mind additional or multiple-site attacks);
- Instruct all ambulant victims to perform self-dry decontamination by partial stripping without using adsorbing products;
- Don proper PPE and prioritise medical care of AU (with RN risks, decontamination is never more important than treatment of AU victims);
- While awaiting the validation of deep decontamination usefulness (or not), increase the chain capacity. For such, multiply the lines in parallel, reduce shower time to less than two minutes (results of Orchid project), facilitate showering by installing a system of successive arches, simplify decontamination chain installation via inciting decision makers to build permanent chains near hospitals (Fig. 42.1), and even using rugged solutions (e.g. screens to separate zones, etc.);
- If the shower lines are insufficient, remember that complete disrobing remove the maximum of the contaminating agent;
- Prepare containers to put clothes and personal things and keep them in check in a specific zone.

Fig. 42.1 Decontamination chain example. (Source: DGSCGC)

Emergency Dry Decontamination

43

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43.1 What You Should Know

The objective is to decontaminate victims as quickly as possible by removing (adsorption, shower) the contaminants, whether known or not, to avoid:

- Worsening the initial poisoning (toxic compounds trapped in hair and clothes);
- Transferring the contaminants to responders, relatives, and buildings.

Immediate dry, also called emergency, decontamination aims at reducing the quantity of chemicals carried by victims and reducing

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the risk of poisoning by inhalation, ingestion, and skin and conjunctival contact.

Deep, also called wet, decontamination (total disrobing, shower) aims secondarily at eliminating all traces of contaminants.

In Case of

- Chemical agents, the emergency decontamination consists in partial stripping, i.e. removing the outer layer of clothes and shoes, and applying an adsorbing agent on the skin such as decontamination gloves (containing Fuller's Earth), Reactive Skin Decontamination Lotion (RSDL)-impregnated sponge, DECPOL gloves, or even a simple absorbing paper, and eye lavage in case of irritant chemicals;
- Radiological particles: the aim is to prevent external contamination from becoming internal: partial stripping should be gentle, without agitation, to avoid dispersing highly volatile radiological dusts, and without exposing the skin to avoid burns. Water spray helps fix the dust on clothes. Following this, use showers if nearby.

During the dry decontamination procedures, victims should protect their airways (FPP2 or FPP3 masks for radiological substances), and should not drink or eat or smoke [1, 2].

43.2 What You Should Understand

Systematic and immediate emergency decontamination is often self-performed. Clothes and personal belongings are bagged, tagged, and maintained attended.

Deep decontamination chain is activated at the start. The need for it is confirmed once the detectors and then the identification process prove the presence of persistent first line hazardous chemicals, notably nerve and blistering agents or if the presence of radiological substances is immediately detected.

Decontamination procedures must not delay medical or surgical management of AU casualty. In case of chemical agents, stripping will be done by PPE-protected staff, and in case of

radiological substances, the victim will be transported to the operating room wrapped in two vinyl sheets [3].

Decontamination procedures should be followed by antidotes injections and oxygen therapy whenever indicated.

In case of exposure to mustard gas, which does not give clinical signs immediately, instructions will be transmitted via official channels to victims who have already left the scene and went back home.

43.3 What You Should Do

- Do risk analysis and train staff to detect events involving the use of CBRN-E products, and to don PPE (courses of Emergency care management [*GSU in French*], UHC [*SSE in French*], Army Health Services [*SSA in French*], EDF (France electricity), LFRS [*SDIS in French*]);
- Respect zones limits, start dry decontamination at casualty collection point;
- Stay in contact with the field EOC and dispatch centres, decide with the EOC the possibility of transferring critical victims without decontamination toward specialised hospitals;
- Prepare dry decontamination kits and flyers in many languages to explain self-decontamination procedure (Fig. 43.1);
- Arrange, whenever indicated, children-specific procedures;
- Ensure that all primary, secondary, and tertiary care facilities have the capability to perform dry decontamination [4];
- Protect first responders by having them wear one-size-fits-all headgears and nitrile gloves before they give primary instructions to victims (using loudspeaker) whilst staying at distance from them.

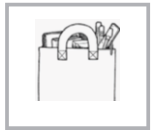
For All Concerned Healthcare Establishments

- Train responders on emergency decontamination and equip them [5];
- Plan field exercises on emergency decontamination.

Contaminated victim kit–procedure

Victims should put on gloves

Put on FPP2 mask and head cap



Put personal things in a transparent bag

Tag and seal

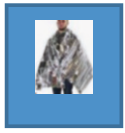
Take off the outer layer of clothes and shoes

Put clothes in a transparent bag

Tag and seal

Put on an overall and single-use shoe covers

Change the gloves



Wrap yourself in a thermal blanket

CHU Hôpitaux de Bordeaux

Fig. 43.1 A flyer explaining self-decontamination procedures

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Children and Disasters

44

Luc Ronchi and Michaël Moris

44.1 What You Should Know

The presence of children casualty in disastrous events (terroristic attacks or accidents) is very common if not always.

A child is not just a small size adult.

The emotional reaction of emergency workers increases when it comes to manage a child.

44.2 What You Should Understand

A child is particularly vulnerable:

- Unable to correctly appreciate the situation;
- Particularly sensitive to cold environment as it increases caloric loss;
- Higher risk of gas or toxic fumes inhalation given the small size.

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Field initial triage should be based on a child-specific algorithm (JumpStart) [1].

Whenever present on scene, parent(s) should not be separated from their children unless necessary.

Hypovolemic decompensation (haemorrhagic shock) often occurs suddenly without preceding signs.

Circulatory and respiratory resuscitation equipment should be adapted to the size of young victim(s).

External decontamination procedures (undressing, adsorption of chemicals by Fuller's Earth) for very young children (<30 kg) require the help of an adult.

Inserting an IV line might be more difficult than in adults [2].

Dosage of medicines and fluids should be calculated according to child's weight.

The risk of administering wrong doses (over or under dose) is higher in children in such circumstances.

Prior exercising (Drill training) grants success in case real events occur.

44.3 What You Should Do

- Roughly estimate the prevalence of children among casualties;
- Anticipate the absence (school bus transport) or significant presence (school outing, public transport) of parents or adults;
- Immediately categorise every child according to their estimated weight (<10 kg, 10–30 kg, >30 kg) in order to adapt equipment and dosage of medicines accordingly;
- Uphold, as long as possible, a reassuring attitude;
- Do not "strive" to insert an IV line (central IV line is contraindicated here), insert an IO line after two failed attempts [3];
- As soon as possible, refine weight estimation [4] using a tape without neglecting the risk of cross contamination, and install children collection point under the authority of a healthy adult (e.g. a teacher) present on scene;

- Pay great attention to the quantities of injected medicines (high risks of errors in terms of dilution, volume, and mass), as follows:
  - Atropine: 0.05–0.1 $mg.kg^{-1}$ (pay attention to packaging),
  - Pralidoxime 20–40 $mg.kg^{-1}$,
  - Diazepam 0.2–0.3 $mg.kg^{-1}$,
  - Hydroxocobalamin 70 $mg.kg^{-1}$ in 15 min,
  - AIBC (Ineurope®) syringe to use in those of more than 30 kg;
- Do not neglect the issue of identifying these young victims not always capable of stating their identity;
- Do not delay transmitting information to MED about the estimated number of children and precise their numbers per major weight categories (*cf. supra*).

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45 Pharmaceutical Preparedness in Disaster Medicine

Claude Renaudeau

45.1 What You Should Know

Pharmaceutical preparedness in disaster medicine should meet the qualitative and quantitative needs of the various levels of the emergency chain. Such needs depend on the disaster type and concern medicines including oxygen, sterile and non-sterile instruments, as well as biomedical and medical emergency materials.

Healthcare responders carry with them individual bags containing what they need to provide care on scene and during transport of casualty to the advanced medical post (AMP).

Referenced, repositionable, and deployable lots have been designed by the concerned public services:

- NOVI (numerous victims) lots of LFRS: those are internal pharmacies implemented by pharmacists at the deployed AMPs and equipped to manage 12 victims;
- Multi-purpose lots: they form the mobile medical posts (MMP) (Fig. 45.1), each contains equipment to manage 200 victims, and are put under the responsibility of a hospital pharmacist [1].

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Fig. 45.1 View of MMP (*PSM in French*) of SAMU 94 (*Photo SFMC*)

These lots are used to deal with mass casualty, notably:

- Stop haemorrhage, vascular perfusion;
- Oxygenation by intubation-ventilation, exsufflation and drainage;
- Administer analgesics and antidotes;
- Immobilise limbs and wound dressings;
- Protection from hypothermia, etc.

Irrespective of the selected packaging type, the boxes should have appropriate weight to facilitate their handling, as well as numbers to help track pharmaceutical lots, in particular manage expiry dates and be able, if needed, to withdraw them in case of pharmaco or materio-vigilance alerts.

Special attention should be paid to medicines sensitive to heat variation, and to the management of narcotics.

45.2 What You Should Understand

On scene, healthcare givers should have easy access not only to pharmaceutical consumables and biomedical materials in order to renew their supplies, but also to pre-packed kits previously prepared and put at their disposal to treat variety of diseases.

Similarly, in terms of preparation and dispensing, especially of injectable forms, the pharmaceutical industry has endeavoured to make all easier and time saving.

Prescribing oxygen therapy requires the presence of sufficient volumes of oxygen, medical devices to administer it, including delivery manifolds where around ten victims [2] could be treated simultaneously.

Managing 50 victims with oxygen therapy at 10 L/min imposes the procurement of 30,000 L of normobaric oxygen per hour, i.e. 10 cylinders of 15 L/h or 30 cylinders of 5 L.

45.3 What You Should Do

Once alerted, it is important to know the nature of the disaster, the number of casualty, and types of injuries (trauma, burns, poisoning, CRN threats) in order to prepare the event-adapted means, in particular, the required amount of oxygen to transport to the scene.

Do it:

- Provide caregivers with symptomatic treatments and, whenever available, antidotes, if there are [3];
- Collect biomedical materials and medicines of the Health and Medical-Aid Service and of SAMU in one place under the coordination of a pharmacist;
- Reconstitute medicines and prepare medical materials so that they are ready for use by providing operational tools e.g. pharmaceutical trays containing pre-filled syringes;
- Organise medicines delivery circuit;
- Initiate inventory tracking of medical stocks;

- Use field pharmaceutical records to track the medical products administered to every victim;

At the end of the intervention, recover empty oxygen cylinders, all unpacked consumables, all used materials, as well as infectious medical waste generated by healthcare activities.

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Antidotes for Chemical and Radiological Agents

46

Claude Renaudeau

46.1 What You Should Know

Antidote is a drug that attenuates or counteracts the harmful effects of a poison, improves the patient's condition or organ function [1].

Concerning chemical warfare agents, we only have antidotes for organophosphorus nerve agents (OPN), cyanides and cyanogen agents, and Lewisite, a vesicant agent.

Concerning RN exposure, antidotes reduce internal radiological contamination and consequently reduce the risk of radiation-induced cancer. Although antidotes are to be given as early as possible, they come second in priority to emergency medico-surgical treatment [2] in such conditions.

46.2 What You Should Understand

Antidotes (Fig. 46.1) are complementary symptomatic treatments for consciousness, ventilation, and blood circulation. Airways clearance, oxygen therapy, and monitoring of vital signs are a priority.

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Fig. 46.1 Antidotes lots of CCP of LFRS 69. (Photo from Claude Renaudeau)

High influx of poisoned victims should be met with big volumes of oxygen and antidotes; hence the need to anticipate

Available antidotes are:

- Radiogardase® (ferric ferrocyanide) increases elimination of Caesium and Thallium with stools by blocking their enterohepatic circulation;

- Calcium diethylene-triamine-penta-acetate [Ca-DTPA] is a chelating agent that forms complexes with radioactive cations of Americium, Curium, Plutonium, Thorium, cobalt, and iron, which are excreted with urine

Lewisite chelating agents work on heavy metals like lead and mercury.

46.3 What You Should Do

On scene, at casualty collection point (CCP), or at hospital reception point where victims have not been decontaminated yet, responders should don their PPE: chemical-resistant gear, appropriate-size face mask equipped with wide-spectrum filter cartridge, butyl gloves, and over-boots.

Concerning Chemical Threats

In OPN poisoning:

Managing OPN casualty relies on cardiorespiratory resuscitation, injecting atropine sulphate, injecting oxime, and administering benzodiazepine as anticonvulsant (Table 46.1) [3, 4].

In cyanide ions poisoning (hydrocyanic acid, cyanide salts, and cyanogen agents):

- Asymptomatic patient: O_2 flow at 6 L/min; mild poisoning: O_2 flow at 10 L/min;
- Moderate poisoning: O_2 flow at 12–15 L/min + hydroxocobalamin (Cyanokit®) **bolus IV of 5 g in 15 min**. In children: 70 mg/kg without exceeding 5 g in total [5].
- Severe poisoning: double the initial bolus dose (add another 5 g) in slow IV (15 min to 2 h). In children: also double the injection without exceeding 140 mg/kg in total.

If cyanide or other cyanide-derived products poisoning is **specified** and confirmed, Dicobalt EDTA (Kelocyanor®) can be used at a dose of **two 20 mL-ampoules** of 1.5 g in 100 mL, i.e.

Table 46.1 Antidotes for OPN poisoining: dosages for adults and children

Medicines	Adult	Child
Atropine sulphate®	**2 mg slow IV** every 5–10 min till bronchial secretions dry up	**0.05–0.10 mg/kg/h**
(Ampoule of 1 mg/mL)	*AHS doctrine*: double the dose till the desired effect is achieved	
(Vial of 40 mg/20 mL of Army Health Services AHS)		
Pralidoxime Methyl sulphate, Contrathion®	**400 mg slow IV** or in infusion	**20–40 mg in 15 min**
(Box of 10 vials of 200 mg + 10 mL of 0.9% NaCl)	Follow-up dose: **200–400 mg/h**	Follow up dose: **10 mg/kg/h**
	If not better 36 h after, stop Contrathion® injections	
Benzodiazepines	**Diazepam** = Valium®	**Diazepam**: **0.2–0.3 mg/kg slow IV** or **0.5 mg/kg** intra-rectally
(Valium®, box of six 2 mL ampoules of 10 mg)	**0.1–0.2 mg/kg** or	Follow-up dose: Repeat the first dose 10–20 min later
	10–20 mg at once IM or slow IV.	
	Follow-up dose:	
	100 mg at 8 mg/h rate	
(Rivotril® box of six 1 mL ampoules of 1 mg)	Or **Clonazepam** = Rivotril®	Clonazepam: **0.25–0.5 mg** diluted in one solvent ampoule, **very slow IV**
	1 mg IV in 3 min	Follow-up dose: repeat the first dose in the hour following the injection
	Follow-up dose: **4–6 mg over 24 h slow IV** or **0.1–0.25 mg/h**	
(Midazolam® box of six 10 mL ampoules of 50 mg)	If pain persists:	
	Midazolam = Hypnovel® **0.15 mg/kg**, available in MMP lots	

Table 46.1 (continued)

Medicines	Adult	Child
Ineurope®	AHS bi-compartment auto-injector.	
	Prepare a lyophilised mixture for **IM injection** of:	
	• 2 mg of atropine sulphate;	
	• 350 mg of pralidoxime methyl sulphate;	
	• 20 mg of avizafone chlorhydrate.	

600 mg IV in 30 s. It is imperative to follow this injection by an injection of **50 mL of 30% glucose** to overcome the **hypoglycaemic effects** of Kelocyanor®.

In children, **there are no paediatric data** concerning treatment by Kelocyanor®.

If blood pressure does not rise, inject a third ampoule of Kelocyanor® of 300 mg eventually followed by 50 mL of 30% glucose.

Both treatments are allowed in pregnancy

In Lewisite poisoning (2-chlorvinyl-dichlorarsine):

The presentation of this poisoning could include foamy sputum and skin burns of the size of a hand palm. If the contaminated area represents more than 5% of the body surface: give **deep IM** of **Dimercaprol (BAL®: British Anti-Lewisite)** (box of twelve 2 mL-ampoules, each contains 200 mg of Dimercaprol and 1 mg of Butacaine in oily solution) at a dose of **2–3 mg of Dimercaprol/kg** without **exceeding 200 mg per injection** [4, 5].

Give the first injection as early as possible, followed by a follow-up injection every 4 h for 2 days; then every 6 h the third day, and every 12 h for the following 10 days.

Other possibilities: use water-soluble chelating antidotes for heavy metals (lead, mercury, nickel, arsenic, and cadmium) in a way to accelerate their elimination with urine.

DMSA (meso-2,3-dimercaptosuccinic acid or **Succimer**) is commercialised in **capsules of 200 mg, Succicaptal®.**
The dose is: **10 mg/kg every 8 h without exceeding 1.8 g a day for 5 days**; **then 10 mg/kg every 12 h for 14 days.**

Concerning Radiological Threats

Potassium iodide in form of 65 mg-containing divisible tablets.
Prescribed by the competent authorities. The tablet (tab) is to dissolve in a drink (Table 46.2) [4, 5].

Prussian blue = Radiogardase® capsules of 500 mg (Table 46.3).
Treatment used in pregnancy.

Ca-DTPA injectable solution of 250 mg/mL in ampoule of 4 mL (Table 46.4).
Ca-DTPA can be used topically to decontaminate external wounds or the skin by pouring the contents of several ampoules on it.

DMSA (Succimer) Succicaptal®
10 mg/kg every 8 h without exceeding 1.8 g a day, for 5 days; then 10 mg/kg every 12 h for 14 days.

Table 46.2 Dosages of Potassium Iodide per age, given as tablets of 65 mg

Age	Dosage
Adults and teenagers of >12 years	**2** tab of 65 mg
Children of **3–12 years**	**1** tab of 65 mg
Infants of **1–3 months**	½ a tab of 65 mg
Newborn till 1 month of age	¼ of a tab of 65 mg

Table 46.3 Dosages of Prussian blue (Radiogardase) per age, given as capsules of 500 mg

Age	Dosage
Adults and teenagers of >12 years	**3 g given 3 times/day** per os
Children of **2–12 years**	**1 g given 3 times/day** per os
Newborn and infants	No data

Table 46.4 Dosages and adminstration routes of Ca-DTPA per age, given as 4-mL amplules of 1 g

Age	dosage	Administration route	Treatment duration
Adults and teenagers of >12 years	0.5 g a day (i.e. ½ ampoule)	**Slow IV or infusion of 15 min** in 100–200 mL of isotonic solution or 5% glucose solution	• 1 inj/day for 3–5 days
			• **2–3 inj/week** for 3 weeks
			• 1 inj/week for 3 months
Children of <12 years	**14 mg/kg** without exceeding 0.5 g/day	Idem	Idem

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Mobile Medical Post (MMP)

47

Catherine Bertrand, François Soupizet, and Éric Lecarpentier

47.1 What You Should Know

Concept of MMP lots and some historical background:

- 1935–1944: lots of "passive defence";
- 1950–1955: 400 MMP level 1 distributed in France;
- 1982: creation of doctrine for pre-positioning of medical lots and of the current MMP level 2;
- 2005: creation of MMP level 3 of the national logistic platform;
- 2016: creation of paediatrics lots, adding one antidote chest to every multi-purpose batch.

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Employment Doctrine

In forecasted or ongoing uncommon health crises affecting any part of the country, consolidate medicines, medical devices, and equipment required to provide emergency healthcare service.

Composition

The allocated supply comprises more than 200 pharmaceutical references and medical devices. The contents are distributed in chests in a way to form four functional lots, each calculated to cover 25 absolute urgent cases (AU), and two main lots to manage 200 AU cases each, i.e. the allocation of a single MMP suffices to manage 500 victims (Fig. 47.1).

Example

Composition of multi-purpose lots (Table 47.1):

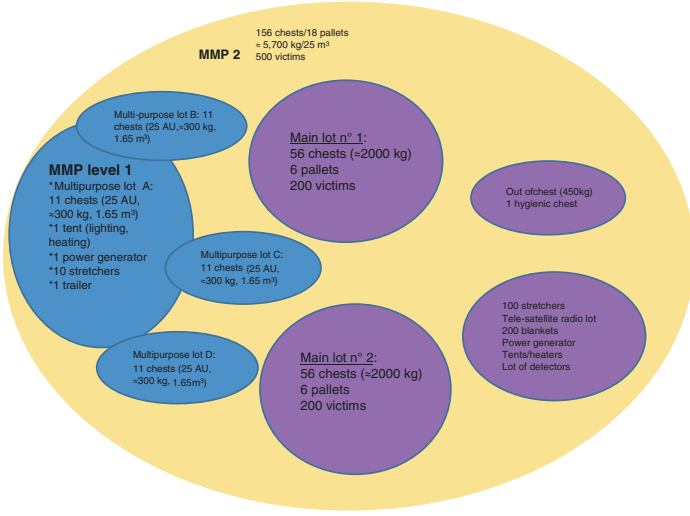

Fig. 47.1 Composition of MMP lots, level 1 and 2

Table 47.1 Multipurpose lots content, numbers and colour of strapping (given as example)

Numbering	Strapping	Contents
A0-B0-C0-D0	White	Ventilation/SPS[a]/Aspiration
A01-B01-C01-D01	Blue	Ventilation
A02-B02-C02-D02	Blue	Ventilation/intubation
A03-B03-C03-D03	Red	Infusion/damage control
A04-B04-C04-D04	Red	Liquids/damage control
A05-B05-C05-D05	Red	Liquids
A06-B06-C06-D06	Green	Medications
A07-B07-C07-D07	Yellow	Dressings
A08-B08-C08-D08	Grey	Small materials
A09-B09-C09-D09	Brown	Big materials/damage control
A10-B10-C10-D10	Yellow	Immobilisation

[a]Self-propelled syringes

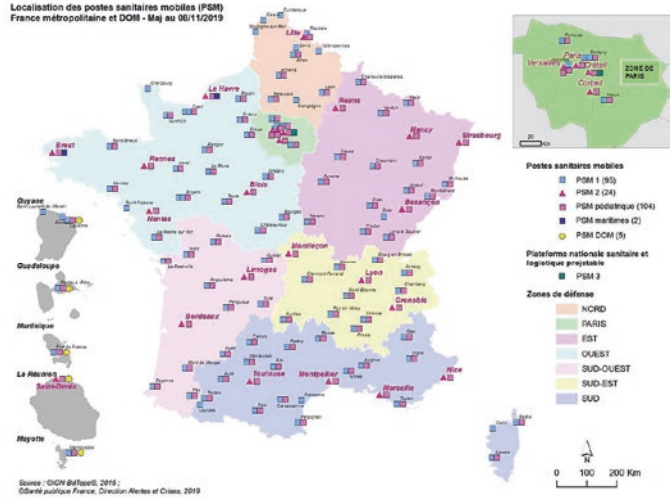

Fig. 47.2 A map showing ditribution of MMP in France mainland and DOM

Distribution

Location of mobile medical posts (Fig. 47.2).

In France mainland and DOM—updated.

Maintenance

Given it is allocated equipment, it is the responsibility of the hospital to maintain and renew it. The hospital pharmacist is in charge of maintaining the batches (expiry date, recycling, storage conditions).

Hospitals receive annual funding for the maintenance of MMP level 2 (called *MIG-PSM* in French).

The Particular Case of the National Platform Located at *Henri Mondor* University Hospital

Objective: reinforcement of emergency medical assistance in case of major disasters all over France and abroad.

Available 24/7, 365 days/year.

Aero-transportable batches in France and abroad (dedicated vehicles, access to airports).

Granted autonomy thanks to power generators, radio communication, tents, etc.

Managed by nominated staff of a functional unit.

MMP level 3 is owned by the Health Ministry and administered by *Santé Publique France* SPF (France Public Health [former EPRUS]).

MMP level 3 or part of it is mobilised at the request of the Ministry on behalf of SPF.

RETEX: Pakistan, Gaza strip, Haiti, the West Indies, Mayotte, Syria, COVID crisis, Beirut, etc.

47.2 What You Should Understand

Functionalities

- MMP mobility is determined within the zonal mobilisation plan, which is decided and implemented by the regional health agency (RHA) of that zone;
- The contents of chests are the same nationwide with identical numbering system and software managed by pharmacists using Computerised Uncommon Health Crises Management System (*SIGeSSE*, in French);
- The MMP lots can be used to support hospitals needs or be outsourced for any UHC in the same defence zone, in another

zone, in real time or as a provision planned to cover a crowd-gathering event;
- A multi-purpose lot comprises 11 "MMP chests" and a main lot comprises 56 "MMP chests";
- A paediatric multi-purpose lot (=Paediatric MMP) comprises 11 "MMP chests";
- The contents of each multi-purpose lot suffice to manage 25 victims, and of the main lot 200 patients;
- The chests are robust, identical to those used by the French Army, and designed to be piled up and easily carried by two people;
- The packaging (weight, volume) is known in advance.

Authority
- Responsibility: director of health establishment, head of department, medical director of SAMU;
- Actuation:
  - SAMU director: (locally),
  - Regional health agency (RHA) and prefect of the defence zone: (regional uncommon health crises, UHC);
  - RHA SPF under authority of Senior Defence and Security officials (*HFDS* in French) of Health/Health Emergency Department HED/Operational centre for the Reception and Regulation of Health and Social Emergencies (*CORRUS*): (national or international events);
- A national commission meets regularly to define and adapt the contents to the good medical practice;
- This commission includes pharmacists, anaesthetists and ER doctors, and logisticians;
- The packaging is validated by a pharmacist.

47.3 What You Should Do

Recommendation at the Departure of MMP
Upon mobilising an MMP, the chests are kept palletised. The pallets are covered in tarpaulin and strapped. For each pallet, the tarpaulin must bear the name of the batch and the numbers of the chests contained in the pallet.

Table 47.2 Weight/volume and number of chests per lot

1 multi-purpose lot	11 chests	292 kg	1.65 m^3
1 main lot	56 chests	1883 kg	8.7 m^3
Cooler	1 chest	10 kg	0.2 m^3
Out of chest (Aniosgel®, HCW[a])	1 chest	25 kg	0.2 m^3

Narcotics are carried in a chest
[a]Healthcare waste

A tracking software record the temperature, humidity, and the number of the security tag of each chest.

Narcotic drugs are transported separately with a prescription.

Some medicines require isothermal boxes.

For missions carried out aborad, it is necessary to know beforehand the volume, weight, and costs of chests, and to list the contents in English for international customs and health formalities (Table 47.2).

Training of SAMU Staff

It is fundamental and integrated as part of exercises of the disaster medicine course, of zonal exercises, and those required to obtain university diplomas (competence and University degree in disaster medicine, expertise degree in managing health emergency responses).

RETEX shows that attention should be drawn to how materials are deployed upon use (it is easier to get everything out than to put it back in the chest again).

Mobilisation of MMP

This step requires:

- A logistic truck to mobilise the entire MMP—better use a temperature-controlled truck with loading tailgate.
- A van or a trailer to mobilise a single multi-purpose lot.

Note: a single multi-purpose lot, given its weight and volume, is transportable by helicopter (EC 135 or EC 145).

PPE of Health Staff

48

Catherine Bertrand, Éric Lecarpentier, and Matthieu Heidet

48.1 What You Should Know

Personal protection equipment (PPE) protects the caregivers as it blocks the entrance pathways (airways, digestive, skin, and eyes) for toxic substances.

The list of volunteers, who are declared fit to wear PPE by the occupational doctor and who are previously trained and standby 24/7, as well as the features and sizes of their adapted PPE are mentioned in ORSAN-CRN plan.

Employers have to train their personnel and consult the committee of health, safety, and work conditions (*CHSCT* in French) in this concern.

CBRN PPE of heath staff are classified under category III/C of EU: provide protection against risks that can lead to irreversible

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or mortal injuries. The PPE is composed of several pieces assembled to provide good seal:

- Airways protection using broad-spectrum filtering cartridge A2B2E2K2P3 (not for carbon monoxide or iodine vapours) mounted on a face mask or a CBRN hood;
- Body and head skin protection, air-permeable or impermeable (see Fig. 48.1), with no leak at conjunction with hands and foot wear.

Chemical PPE provides total protection even against alpha and beta emitting radionucleotides, hence the need to don such PPE as long as the risk has not been identified.

For RN events, the responders carry a dosimeter underneath their gears.

For epidemical and biological risks, the PPE type will depend on the contamination route (recommendations of the national coordination for epidemiological and biological risks, *COREB* in French).

Only military CBRN PPE meets mandatory standards. Civil PPE is assessed by a notified body based on expert opinion, and is

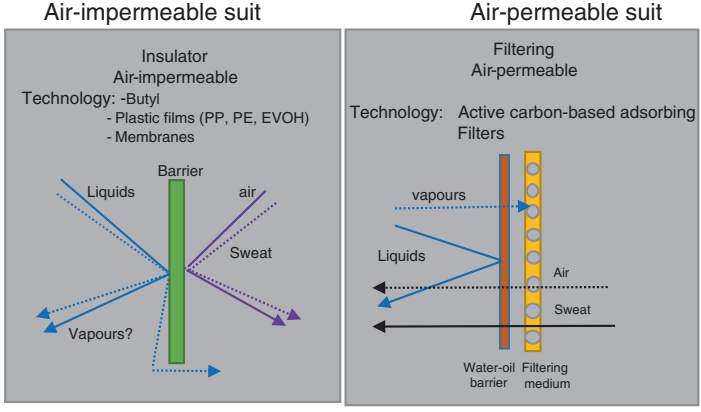

Fig. 48.1 Difference between insulant and filtering fabrics

CE certified when it fulfils the Essential Health and Safety requirement (EHSR).

48.2 What You Should Understand

Health staff PPE should be adapted to fit a wide range of ages, sizes, having beard or long hair, wearing glasses, and with a lower training level than that of militaries.

Anticipating the spontaneous arrival of contaminated victims (80% of ambulant people according to the literature) comes with wearing a first-line PPE (face mask and gloves) before being able to don the entire PPE.

Wearing PPE is inconvenient due to the restricted vision, hearing, and dexterity, as well as the physiological burden it imposes: the air-impermeable suit in hot weather forces the team to use a 1-h-long shift, whereas the air-permeable suit (allows sweating) can be used for more than 2 h in the same conditions (tested in the European project IFREACT [1, 2]).

Adding a positive pressure respirator to the face mask improves breathing and remarkably reduces the PPE physiological burden.

The development of an overpressure CBRN hood, with no face mask, but with a large visor (IFREACT project) made it possible for a responder to keep own glasses, to better see, and be seen by victims.

P3 cartridge filtration is similar to that of FFP3 masks.

48.3 What You Should Do

- Subscribe into a qualification course (*GSU SSE* in French) and its annual exercise on C, RN, and B PPE donning performed using training PPE to simulate the difficulties of wearing real PPE;
- Harmonise procedures between services. Donning is performed in pairs. PPE is sealed only upon entering the contaminated zone;

- Check the storage conditions, the expiry dates (10–15 years for suits, 10 years for masks and cartridges), and the maintenance (masks, batteries, cleaning of training suits);
- Anticipate stress and reduced performance and engage supervisors and communication means;
- Test destocking procedures: It is better to have a tool that provides immediate protection like a hood (fast to don, wide visor, over-pressurised, one-sized, in adult, child, or infant versions, cartridge A1B1E1K1P3);
- Test PPE ergonomic: a one-piece suit is preferred on a two-piece (jacket-trousers) suit; thickness of gloves according to work task (dexterity needed for antidote injection or logistic tasks); selecting overboots to don over work shoes or suit-integrated socks;
- Compile a description book of user requirements. Some air-permeable suits keep their properties even when wet, hence the interest of using them in the shower zone to reduces staff shifts;
- Ensure tracking, decontamination, and medical monitoring of health givers at zone exit.

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2. CORDIS (n.d.) Final report summary – IF REACT (Improved First Responder Ensemble Against CBRN Terrorism). CORDIS, Luxembourg. https://cordis.europa.eu/project/id/285034/reporting

FMC, SINUS, and Patient Tracking in Disasters

49

Éric Lecarpentier and Catherine Bertrand

49.1 What You Should Know

Managing casualty requires good tracking to inform the hospital staff who will receive the victim, the family, and the authorities about the victim's clinical condition, treatment they received, as well as the evacuation destination. A disaster situation is particular in terms of the big number of casualty and responders (emergency workers, care providers), hence the need to continuously sort out victims, all along the emergency and care chain, into AU, RU, delayed, or dead.

Tracking relies on two complementary systems [1]:

- A paper document: field or disaster medical cards (FMC) on which administrative data, category (based on how critical the patient is), main complaints, treatments, and the evacuation destination are written. FMC is attached to the victim until reaching the destination (Fig. 49.1).

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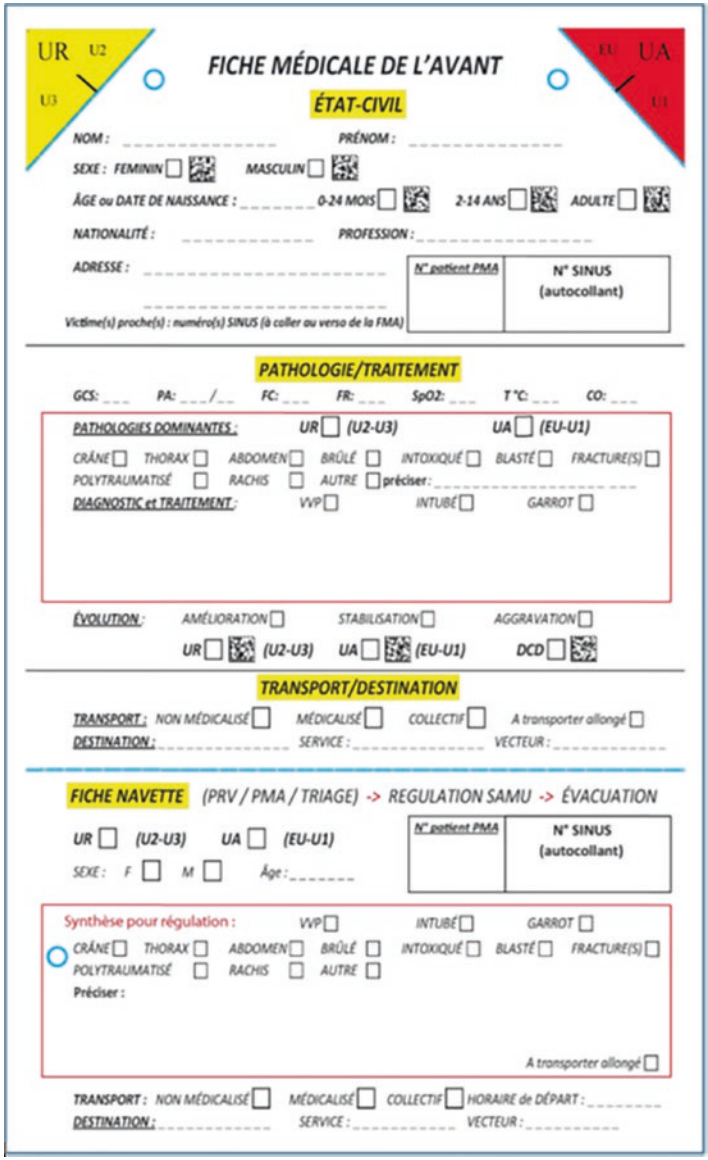
UR U2 U3

FICHE MÉDICALE DE L'AVANT

EU UA U1

ÉTAT-CIVIL

NOM : _____ PRÉNOM : _____

SEXE : FEMININ ☐ MASCULIN ☐

ÂGE ou DATE DE NAISSANCE : _____ 0-24 MOIS ☐ 2-14 ANS ☐ ADULTE ☐

NATIONALITÉ : _____ PROFESSION : _____

ADRESSE : _____

_____

Victime(s) proche(s) : numéro(s) SINUS (à coller au verso de la FMA)

N° patient PMA	N° SINUS (autocollant)

PATHOLOGIE/TRAITEMENT

GCS: ___ PA: ___/___ FC: ___ FR: ___ SpO2: ___ T °C: ___ CO: ___

PATHOLOGIES DOMINANTES : UR ☐ (U2-U3) UA ☐ (EU-U1)

CRÂNE ☐ THORAX ☐ ABDOMEN ☐ BRÛLÉ ☐ INTOXIQUÉ ☐ BLASTÉ ☐ FRACTURE(S) ☐

POLYTRAUMATISÉ ☐ RACHIS ☐ AUTRE ☐ préciser : _____

DIAGNOSTIC et TRAITEMENT : VVP ☐ INTUBÉ ☐ GARROT ☐

ÉVOLUTION : AMÉLIORATION ☐ STABILISATION ☐ AGGRAVATION ☐

UR ☐ (U2-U3) UA ☐ (EU-U1) DCD ☐

TRANSPORT/DESTINATION

TRANSPORT : NON MÉDICALISÉ ☐ MÉDICALISÉ ☐ COLLECTIF ☐ A transporter allongé ☐

DESTINATION : _____ SERVICE : _____ VECTEUR : _____

FICHE NAVETTE (PRV / PMA / TRIAGE) -> REGULATION SAMU -> ÉVACUATION

UR ☐ (U2-U3) UA ☐ (EU-U1)

SEXE : F ☐ M ☐ Âge : _____

N° patient PMA	N° SINUS (autocollant)

Synthèse pour régulation : VVP ☐ INTUBÉ ☐ GARROT ☐

CRÂNE ☐ THORAX ☐ ABDOMEN ☐ BRÛLÉ ☐ INTOXIQUÉ ☐ BLASTÉ ☐ FRACTURE(S) ☐

POLYTRAUMATISÉ ☐ RACHIS ☐ AUTRE ☐

Préciser :

A transporter allongé ☐

TRANSPORT : NON MÉDICALISÉ ☐ MÉDICALISÉ ☐ COLLECTIF ☐ HORAIRE de DÉPART : _____

DESTINATION : _____ SERVICE : _____ VECTEUR : _____

Fig. 49.1 Field medical card (in French for national use)

- A digital record system (since 2016): Standardised Digital Information System (named ***SINUS*** in French) which counts victims and their categories and can immediately transmit data. The system is interconnected with the hospital Victim Health Information System (***SIVIC*** in French) for identification-surveillance purposes.

49.2 What You Should Understand

SINUS bracelet comes in a batch of 10 bracelets attached by a ring where each bracelet is pre-printed with a unique national registration number and should be put around the wrist as early as management starts, if possible, at the same time as FMC is issued. Each bracelet has six self-adhesive stickers carrying the same QR code to use in the FMC, the paper dashboard of the AMP where victims are listed, and to track stored personal belongings. All field responders (sapper-firefighters, rescuers, police, SAMU-SMUR) can attribute bracelets to victims. One sticker of each bracelet stays in the ring for quick entry into *SINUS* (Fig. 49.2).

SAMU or regional health agency, RHA open an event file in Victim Health information system, *SIVIC*. Entering data into *SIVIC* (patient's *SINUS* number and category) is carried out by administrative staff at hospital admission.

Fig. 49.2 Identification bracelet with QR codes

SIVIC identifies, by name (identity surveillance), patients who arrived at the hospital, evacuated from the field with a *SINUS* number, or arrived spontaneously at the ER without a *SINUS* number. Patients spontaneously flowing into the ER of any hospital, coming from the same event, are registered in *SIVIC*. A *SINUS* number is automatically generated for each.

In terroristic events, and after approval of RHA, *SIVIC* information is synchronised with that of *SINUS* so that the Interministerial Victim Support Service can inform the families.

In disasters, *SINUS* and *SIVIC* lists are sent to the public prosecutor. If there is no *SINUS* tool, the FMCs are used to collect prehospital information.

49.3 What You Should Do

- Attribute an FMC and/or a *SINUS* bracelet to every victim (alive or dead) in every mass casualty incident. A sapper-firefighter officer opens a *SINUS* event file. Entering data into *SINUS* is performed as close as possible to the event;
- Open a *SIVIC* event file (SAMU or RHA) and link it to the corresponding *SINUS* file;
- Enter *SINUS* number and patient identity into *SIVIC* as soon as the patient arrives at the destined hospital;
- Train the local fire rescue service, LFRS and the health establishment staff on how to use FMC and *SINUS*. The administrative staff of the health establishment must undertake a training course and a regular exercise on how to access and upload data into *SIVIC*. Tutorials are published by the French *Agence du Numerique en Santé* (Health Digital agency).[1]

Reference

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Transmission in Disasters

50

Éric Lecarpentier

50.1 What You Should Know

Transmission is an essential component of response in disasters. Transmitting information from the field to the decision-makers is vital and should be considered in both directions.

The information circuit and the points of convergence or synthesis must be organised before the crisis and tested during simulation exercises. The latter should integrate several scenarios, e.g. lack of some technical tools or levels of synthesis, in order to overcome obstacles and maintain continuous management of the crisis.

Technical tools should be resilient to compensate for a possible breakdown at the time of the crisis or disastrous event. In some situations, messages are encoded before transmission for security purposes. In case of breakdown of land-based transmission system (GSM, radio), satellite transmission (phone and data) is used.

All responders are required to master these technical tools and for such, they are incited to use these tools at daily work and at regular basis.

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Paper documents should contain essential elements of functionalities and the methods and codes of connexion.

Several organisations or institutions, of the same country or of several nations, can manage a single crisis. Each institution should envisage common contact points through which field feedback and coordinated decisions circulate from and to the field respectively. Exchange between the different information systems can also be considered.

50.2 What You Should Understand

Transmission tools used in crises are those of daily life. Each organisation defines its way of communication. There are convergence points to unite all.

Two types of transmission are to consider: synchronous transmission which necessitates the presence of two or more speakers at the same time (e.g. telephone or radio), or asynchronous transmission where information can be exchanged with no speakers present instantaneously (e.g. E-mails).

Each participating organisation should have its own crisis contact details:

- Unique telephone number;
- Generic E-mail address;
- Radio identifier and radio frequency.

These contact details are collected in the crisis directory, which is given to all conventional participants before the crisis. The directory is regularly updated.

On scene, responders should be able to communicate easily with their operational centre. It is preferred to use radio or mobile phones. In France, ANTARES network (*Adaptation Nationale des Transmissions Aux Risques Et aux Secours*) unites on the same technology all emergency services.

The prefecture/local government office opens in case of disasters a common conference.

The public mobile communication system (GSM) is often inoperative in case a collective emergency or LIDA occurs, especially in low population density areas, or due to saturation of its relays. In major disasters (cyclones, earthquake, tsunami, etc.) GSM network is cut due to failure of electrical power or physical destruction of its relay towers.

50.3 What You Should Do

Before the Occurrence of the Disaster

- Define the action plan and the transmission means to be accessed by all emergency teams;
- Identify and collect (directory) the unique telephone numbers and generic E-mail addresses of each emergency organisation that has already checked the accessibility and functionality of their tools through regular exercises;
- Collect on the site all CP transmission vehicles [fire fighters, SAMU, police, prefecture, approved civil defence associations (*ASS* in French), etc.]. Check the GSM and radio good functioning and their capacity to transmit information to operational centres.

Respect Basic Conversational Rules

- Make sure that the network is free;
- Respect the calls order;
- Press the switch and wait a second before talking on the radio;
- Present yourself, talk clearly and calmly (do not shout);
- Avoid long sentences, polite expressions, slang or coarse language;
- Make sure your addressee well understood the message;
- Use international alphabet and its number system designation (Fig. 50.1);
- Do not hang up until your caller agrees.

A - Alpha	J - Juliet	S - Sierra
B - Bravo	K - Kilo	T - Tango
C - Charlie	L - Lima	U - Uniform
D - Delta	M - Mike	V - Victor
E - Echo	N - November	W - Whiskey
F - Foxtrot	O - Oscar	X - X-Ray
G - Golf	P - Papa	Y - Yankee
H - Hotel	Q - Quebec	Z - Zulu
I - India	R - Romeo	

For figures: 0 - Zero; 1 - One; 2 - Two; 3 - Three; 4 - Four; etc.

Fig. 50.1 International phonetic alphabet

Correction to: Disasters and Epidemics

Benoît Vivien

Correction to:
Chapter 21 in: H. F. Julien (ed.), *Disaster Medicine Pocket Guide: 50 Essential Questions*, https://doi.org/10.1007/978-3-031-00654-8_21

Owing to an inadvertent error, the legend of figure 21.1 was initially published wrongly. The correct caption of Fig. 21.1 is "Population using contaminated water despite the interdiction. Mexico, earthquake 1985".

The updated original version of this chapter can be found at https://doi.org/10.1007/978-3-031-00654-8_21

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