M

MASS DISASTERS

Contents

Role of Forensic Pathologists

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Introduction

It is very difficult to conceptualize the forensic processing of a mass disaster. Unfortunately, this must be done more and more in this modern era. In the 1990s and more recently, there have been major mass fatality incidents (MFIs) including the TWA airline Flight 800 crash off Long Island, New York, in 1996, the unspeakable destruction of the World Trade Center twin towers in New York City, in 2001, and the 10 simultaneous bombings of commuter trains in Madrid, in 2004. Each event, with its unique multitude of casualties, creates its own set of hardships and circumstances. However, forensic scientists must see the common thread and apply professional protocols even in the face of extreme adversity.

Forensic pathologists, in particular, are called upon to perform perhaps the most gruesome of duties – detailing the physical aspects of the human carnage and helping to identify those who have perished. Families deserve that much – the return of their loved one and the knowledge of how he or she died. This article will document the involvement of forensic pathologists in the mass disaster scenario and how they can proceed with calm, and efficiency, applying forensic techniques in a sea (often quite literally) of fatalities (Figure 1).

Definition

Forensic pathology is the study of postmortem processes and focuses on investigations and autopsies to determine how people die. This discipline is involved with the medicolegal world and the certification of deaths. It is a special branch of the broader discipline of anatomic pathology, emphasizing the gross and microscopic analysis of human tissue taken at the time of surgical or autopsy procedures.

There are two main authorities overseeing death investigation in the USA, the medical examiner and the coroner. Forensic pathologists can serve as medical examiners working for municipal and state governments as the sole authority in explaining and certifying all sudden, unexpected, or unnatural deaths. Forensic pathologists can also serve as consultants to elected coroners providing pathologic expertise to the death investigation while the coroner remains the certifying authority. The goal of each system is the same, namely the determination of the cause and manner of death for an individual dying in sudden, suspicious, or traumatic circumstances. Unfortunately, the difference in the jurisdictional structure leads to a lack of uniformity in attaining this goal.

Forensic pathologists are physicians and as such take the Hippocratic oath to "do no harm." This applies to all patients, the dead as well as the living. Forensic pathologists are the deceased's advocate, speaking for them when they can no longer speak for themselves. Therefore, even though the magnitude of decedents at an MFI can be overwhelming, forensic pathologists must still apply this credo.

Mass Fatality Incidents (MFIs)

An MFI is considered technically to be any incident resulting in the death of more than one person. However, the practical definition of an MFI is the actual number of deceased determined to be an MFI on a

Figure 1 Temporary morgue. Recovered bodies from the Korean Airlines crash in Guam, August 1997, line the floor of the temporary morgue facility at the US Naval base.

Figure 2 Refrigerated trucks. These vehicles are used for the temporary storage of human remains when the local morgue body cooler capacity is exceeded.

local level and should be defined by the death investigation team prior to the occurrence of an incident. For example, for Onondaga County and three surrounding Central New York Counties of approximately 1 million population, an MFI is considered to be any incident that results in the death of 10 or more people.

A mass disaster, another term sometimes used synonymously with MFI, is really any incident that exceeds available local resources. Thus, in a small rural jurisdiction, a two-vehicle crash with six fatalities might be classified as both an MFI and a disaster. While in a large urban center with a 3 million population, 15 deaths from an industrial accident might not be considered an MFI, though there are mass fatalities, and would be handled through routine processes (Figure 2).

The forensic pathologist brings a necessary expertise to an MFI. Two distinct priorities of every death investigation must also be addressed during an MFI – "identification" and "investigation." For all decedents, the same questions apply – the cause of the death and the identity of the person. The core training and daily experience of the forensic pathologist makes him or her well suited to answer these questions.

Philosophically, it may be asked what is the value of investigating the cause of death in certain obvious tragedies. For example, because the Twin Towers collapsed thousands of people died. Although the massive destruction is the cause of death, the forensic imperative goes well beyond the obvious. It is through the process of methodical death investigation that the forensic pathologist might uncover the sequencing of events preceding the death, as well as unsafe occupational, environmental, or transportation issues. Documenting the injuries and the mechanism of death provides answers to inevitable questions related to a decedent's pain and suffering and leads to changes in design of aircraft, buildings, rescue equipment, and consumer products. Careful scientific analysis also ensures accurate identification of individuals. This forensic approach, to look for answers in the face of human tragedy, provides information to grieving families and on a larger scale, to their communities. Hidden benefits might emerge from a thorough investigation with detailed examinations and autopsies.

It is up to the forensic pathologist to ensure that professional protocols and procedures are followed, decedents properly identified, and the accurate cause and manner of death assigned. It is important to know whether someone died of blunt trauma injuries, or asphyxia due to mechanical compression, or carbon monoxide poisoning from a fire. Though it is not always possible to separate out these individual causes, it is the job of the forensic pathologist to try, even in the face of extreme adversity.

A special approach is needed for the forensic pathologist to properly address the challenging situation of an MFI. It is not easy to draw up an unwavering blueprint of what to do. The following represents a guideline that the forensic pathologist will use and the recommended roles to follow throughout a mass disaster. It should be remembered throughout that flexibility and adaptation are key to a successful operation. Investigating an MFI is literally an attempt to create order out of chaos, which makes each MFI unique.

Notification

The forensic pathologist's work begins at the time of notification of the MFI. The usual method of death notification will be expanded to include information critical for the emergency response. A standard death notification form includes caller's identity, date, time,

and call-back number, specific data about the type of incident, and the agency handling the scene. In an MFI, information about the approximate number of fatalities, exact location of the incident, access routes to use, noteworthy conditions requiring special equipment or specially trained responders, exact location of the command post and staging areas, and the notification tree for appropriate personnel has to be collected.

Every office should have an emergency telephone tree so that each employee knows whom he or she is responsible to notify. Telephone numbers of personnel should be updated as needed on a regular basis and distributed to all staff members. The forensic pathologist needs to be familiar with this process as well as to have telephone numbers of governmental officials, medical personnel, and law enforcement agencies for contact at any time. This allows communication to take place in a timely and efficient fashion.

Advance Team

The first issue confronting the advance team is to ascertain the safety of the scene before actually entering it. The team should be prepared to follow specific biological, chemical, and radiation hazardous materials guidelines for any specialized treatment required in the handling and recovery of decedents. Details provided by the initial emergency responders and law enforcement investigative agencies guide the approaches the team will follow. For example, if there is a possible secondary explosive device, then the recovery of the dead is delayed until the immediate threat to life is handled by properly trained specialists.

The advance team includes the forensic pathologist and makes a preliminary assessment about the MFI. This assessment will consider the condition of the remains with the amount of fragmentation, commingling of the bodies, the state of decomposition, and alteration by the environment. Other items of importance that the team will assess are the incident locale, investigative questions, need for retention of evidence, community concerns, and available resources.

The forensic pathologist provides important expertise to the advance team since he/she is familiar with the normal postmortem processes, the effect of environment and trauma on the human body, proper evidence recovery, and the type of equipment and personnel needed for various tasks.

The advance team makes recommendations to establish a decision tree based on the specific circumstances of the mass disaster. This decision tree will address the constitution and differentiation of common tissue, nonidentifiable remains, and potentially identifiable decedents. Minimal examination will be done with the common tissue. These categories should be clearly defined in advance so that confusion does not result during triage. Every professional must follow the decision tree to avoid inconsistent actions at the autopsy table. When clearly delineated at the onset, it will be easier for everyone to follow a professional protocol.

Recovery of Bodies

An MFI usually begins as a rescue operation. One of the essential qualities of being human is our ability to hope. It is one of the hardest emotional aspects of the operation as efforts turn from rescue to recovery; when casualties become fatalities (Figure 3). However, once this occurs, the necessary structure must be put in place to accurately identify where bodies are recovered.

The forensic pathologist can help to establish a scene grid quickly to identify where remains are uncovered. This grid may use geographical positioning system (GPS) coordinates, geographic points (NE, SW, etc.), or other specific, physical descriptors. It must be a reproducible, permanent, and relevant framework used consistently by all throughout the entire recovery and investigation. Grid coordinates ensure that the pathologist's documentation of injury

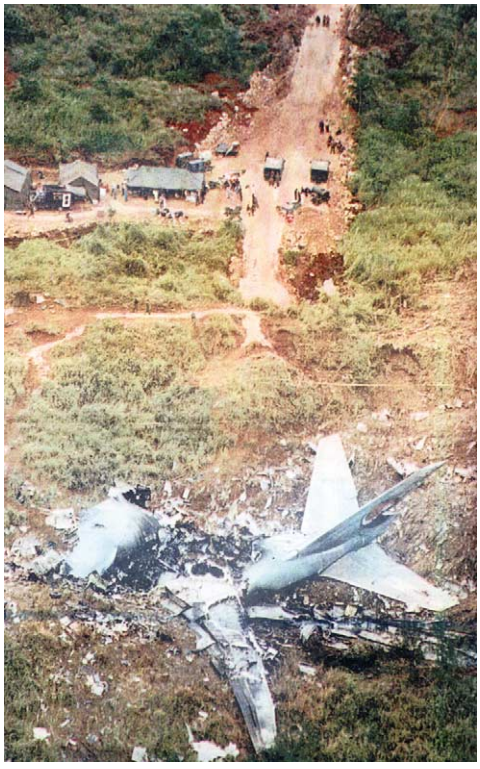

Figure 3 Aviation accident site. This aerial shot of a crashed jetliner reveals severe destruction of the aircraft and wide dispersal of bodies. The road in the upper portion of the photo was created by the military in order to reach the crash site.

will have greater meaning during later analysis. For example, if in one particular segment of the grid, all bodies are intact with minimal trauma, engineers and accident reconstructionists would investigate the physical reasons why this has occurred. Likewise an absence of a pattern may also be informative.

Generally, the human remains will be transported to a temporary morgue for examination. They should be respectfully placed in appropriately sized evidence or body bags and clearly labeled with the grid coordinates. The paper trail has begun and now each decedent can be placed historically back to the scene of the incident. Scientific relevance starts with the scene grid, so that the data collected by the forensic pathologist at the time of autopsy can be correlated to the incident milieu.

Disaster Manual

When an MFI occurs, it is the local jurisdiction that has responsibility for the retrieval, identification, determination of cause and manner of death, and death certification of each decedent. Every jurisdiction must be equipped with a disaster manual in advance with a consideration of available resources, types of disasters that might occur, and the community plan in the event of such an occurrence. A convenient list of available resources with contact numbers should be included in the manual to aid in swift communication. A recommended outline of topics covered in the manual is listed in Table 1.

Any forensic pathologist suddenly faced with an MFI in their jurisdiction will have a monumental set of demands and responsibilities. Those forensic pathologists familiar with emergency jurisdictional procedures can more easily establish contact with the local disaster management team and authorities in the command center. It is useful to work with emergency rescue and hospital personnel, and government and public health officials in a simulated exercise, utilizing the incident command system, and testing the lines of communication prior to a tragedy striking the community.

Table 1 Disaster manual: table of contents

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Table 2 List of nonhuman remains[a] recovered from the World Trade Center and brought to temporary morgue at Ground Zero, New York City, September 2001

Banana
Fig
Tomato
Beef ribs
Lamb chops
Insulation
Wig hair
Jelly
Turkey lunch meat
Kidney
Heart
Thoracic aorta
Small intestine with mesentery
Colon

[a]Initially thought to be human by recovery workers, but careful examination revealed the nonhuman nature of the material.

Triage

Triage involves the prioritizing of services and resources. A primary morgue station should be assembled to include experts from forensic pathology and anthropology, evidence collection, photography, and DNA (forensic biology/serology). This is where the preliminary physical examination of the remains is performed with photographic and X-ray documentation. The remains will be classified as human and potentially identifiable using classic forensic or DNA techniques, or as common tissue with no further identification. No further examination will be done with remains labeled as common tissue.

Not all remains recovered at the time of a disaster will be human. An example of this is provided by the list of nonhuman material recovered at the World Trade Center (Table 2). In particular, nonhuman bones can confuse workers during recovery and may be initially mistaken as human. Rescue workers may recover discarded food (for example, squid or fish).

Specialists at the triage station can make the scientific decision to authorize disposal of the nonhuman

remains, creating a more efficient workflow. If there is any question about the origin of the remains, then further examination should be performed including X-ray, histology, or DNA analysis.

Potentially identifiable human remains are the priority. Each specialist at the triage station provides unique expertise. The forensic pathologist provides soft tissue analysis, while the forensic anthropologist performs skeletal, jaw, and teeth evaluation. Evidence technicians can identify important trace materials while DNA biologists can select the best sites for viable tissue for testing. Photographers document the remains, evidence, and associated property as they are received. X-ray technicians assist with providing quality radiographic films.

At the preliminary examination, a presumptive identification might be made from associated property with the remains, such as clothing, an airline boarding pass, or jewelry. A distinction must be made between clothing and jewelry that are actually on the body part (e.g., a ring on a finger, a helmet on a head) and those items that are near or adherent (e.g., a wallet melded to nearby burned soft tissue, a badge next to an arm). Property physically on the body part is much more useful in a preliminary identification. It can point investigators in the right direction and limit the number of possible victims that this decedent may be. However, the physical property is only a clue to identification. It is not a scientific method for forensic identification of the remains. Consideration of property only (without corroborative scientific evaluation) may lead to false identification. For instance, a deceased first responder may have grabbed a coworker's helmet when responding to the initial emergency.

Computer Assistance

Computer databases are essential to help catalog, organize, and search the mass of information that is gathered at the disaster site. This has been enhanced by the increasing power of laptops, digital cameras, wireless networks, and the internet. For example, the case number and grid data can be immediately entered into a computer as soon as the remains are brought to the morgue. Preliminary examinations can then be entered into a laptop computer at the triage station including the important physical characteristics of the recovered decedent. Identification/case management programs are available and can be obtained prior to an MFI (e.g., WINID®, VIP®).

Concurrently, there is another aspect of the data recovery operation under way – the family assistance center. It is there that the victims' families are interviewed and provide extensive antemortem information about their deceased loved ones. This information includes past medical and surgical histories, physical characteristics, and clothing and jewelry descriptions that are then entered into a computer database. If this database is networked and shared between the family assistance center and the morgue, then a timely comparison of antemortem and postmortem data can be performed. This ultimately leads to proper scientific identifications.

Identification

The identification process utilizes classic forensic techniques to compare antemortem records and postmortem examination data (dental, radiographic, medical, and fingerprint analyses). In addition, DNA testing may be used to compare living relatives or the decedent's own cells left behind in a hairbrush, or toothbrush with DNA of tissue recovered from the human remains. Visual identification or the use of personal property found on the decedent does not meet the standard of a positive forensic identification.

A positive identification is that conclusion of the person's identity that reaches 95% certainty. In legal parlance, this is defined as "within a reasonable degree of scientific certainty."

A presumptive identification is a preliminary determination that narrows down the possible identities of the deceased. For example, following an autopsy, the deceased is known to be an elderly female with prior gallbladder, and appendix surgeries, permanently tattooed eyebrows, and an old amputation of the right big toe. In addition, within the pants pocket, still on the deceased's body, is a boarding pass with the name of Jane Doe. This information provides a likely but still preliminary identity. Further formal scientific examination (fingerprint, dental, and radiographic analyses) is needed to elevate this to the level of a positive identification.

Presumptive identifications are more likely to occur in instances where the decedents' bodies are fairly intact. However, there may be fragmentation and amputations with multiple body parts of a single individual recovered separately. Attention is then directed to remains that provide unique identifiers including hands for fingerprints, teeth for dental records, bones and soft tissue with surgical/metal appliances or prostheses, portions of skulls with teeth or sinuses, vertebrae and ribs, and old fracture sites. These body parts are considered potentially identifiable based on unique physical characteristics of the type and location of tissue. When the classic techniques of forensic identification are vigorously applied, the need for DNA analysis is lessened

and the time required for individual identification shortened.

Some human remains recovered may exhibit no individually identifiable characteristics. Small fragments of bone or soft tissue may bear no recognizable feature. It is unfeasible and untenable to perform DNA testing on all recovered human materials. This is especially true with severe fragmentation resulting from high-velocity impacts. In addition, some remains may be sufficiently incinerated to consist only of powdery gray cremated material. These are scientifically unidentifiable as they are without viable cellular material for DNA testing. Some body parts and tissue fragments will be labeled as common tissue and never traced back to a specific individual. This is an unfortunate but important realization that must be made.

The local jurisdiction must ultimately make the difficult decision how far to continue with the identification process, once all forensic scientific efforts have been utilized. Local resources and the availability of DNA testing will also have an impact on this decision. One scenario might be that fragments of tissue unidentifiable by classic forensic identification modalities (dental, fingerprint, radiology), and measure less than $15 \times 15 \times 15$ cm, will be considered common tissue and no further testing will be done.

Nevertheless, every body part and fragment of tissue should be recorded even if not extensively examined. This documentation is helpful in understanding events and in assessing how many individuals perished.

A daily identification meeting should be held among the scientific specialists and the local authority responsible for certifying the death. This team should approve each individual identification and document the primary forensic method utilized. This ensures that all specialties (pathology, anthropology, fingerprint, dental, etc.) agree on the age, gender, ancestry, and identity of the person. This minimizes the possibility of a misidentification, and provides clear documentation of how each person has been identified.

Release of Bodies

Once the formal identification, examination, evidence collection, and investigative tasks concerning the individual decedent have been accomplished, the death certificate may be signed in accordance with local law. Notification of the next of kin of the decedent should be made in person through the family assistance center when possible. Details of the condition of the body and the remains recovered should be sensitively explained to the family. It is unwise to let them learn of this during their formal time of grieving at the funeral home.

Families will be asked to sign a release authorization that contains the name of their chosen funeral home. This release should also include information on whether or not the family wishes to be notified if any additional remains of their loved one are recovered. It is much easier to ask the family at this time, than several months later. If they do not wish to be notified, then any other remains recovered from that decedent will be considered as common tissue. Local law and custom will address how the common tissue should be handled.

Once the death certificate is signed along with the release authorization, the funeral home may claim the remains. Funeral directors should show identification and acknowledge possession of the decedent and any personal property that is turned over to them.

Personal Property and Evidence

Personal property intimately associated with the decedent that is not deemed evidence is turned over to the next of kin or the funeral director at the time of release of the body. Inventory of unassociated property is taken and cataloged with the hope of reassociating it with the proper family. This is a long-term effort and may require the support of a private agency with the resources to accomplish this task.

Evidence collection begins at the scene of the incident and continues to the triage station of the morgue. Law enforcement personnel responsible for the criminal investigation take custody of any material having evidentiary value. This is done in conjunction with other scientific specialists so that minimal manipulation of the body occurs.

Delegation of Duties

An MFI requires special assignments of responsibility in addition to normal duties. The forensic pathologist may assume leadership and administrative duties as well as performing autopsies. Thus the forensic pathologist must have scientific knowledge, management skills, and the requisite authority. Three vital leadership roles that require the expertise of the forensic pathologist include the commander responsible for overall management of the disaster, commander of daily operations, and morgue team leader who also serves as safety officer.

The commander of the MFI establishes required protocols for autopsies and examinations, approves all final identifications, signs all death certificates, releases information to the media, and coordinates with other command leaders to allocate resources

and personnel. The commander of daily operations is responsible for ensuring that normal day-to-day functions of death investigation continue, and implements requests for outside assistance as needed. The morgue team leader is responsible for overall management of the morgue, creating a safe environment for the performance of autopsies, and assigns and supervises appropriate personnel, consultants, and volunteers for the morgue.

Other team leadership duties involve finance and logistics, search and recovery, records, identification, and family assistance, and these may be handled by other forensic specialists including death investigators. The chain of command should be enforced with personnel reporting to their designated supervisor with any problems, requests, or recommendations.

Communication

Effective interpersonal communication can enhance efficiency, reduce mistakes, and improve productivity. The forensic pathologist as medical examiner is often best equipped to coordinate daily group briefings to update staff on recovery statistics (number of body bags, number of identifications), changes in procedure, and any logistical issues. Such regular updates help workers maintain focus on their mission, boost morale, and limit rumors and fears.

A more extensive meeting can be held at the beginning of the operation and provide details about expectations and procedures along with a thorough review of the established facts of the investigation, and the purpose of the mission. Having workers sign confidentiality statements at this time is helpful in reinforcing an ethical standard of conduct.

Concluding informational sessions provide closure and a sense of accomplishment to people who have worked hard, often separated from their families and isolated from their normal routine.

Intersectional daily briefings by team leaders will ensure that each section (pathology, anthropology, dental, fingerprints, radiology, DNA) is aware of the issues of the other specialties and are updated with current concerns or changes in procedure. Brief intrasectional meetings at the change of shift will enhance efficiency, and encourage cooperation. Both provide opportunities for input and change in the challenging and stressful environment of a disaster.

Families of the victims must also be updated on a regular basis and receive accurate and timely information from the appropriately knowledgeable source. Often this is the forensic pathologist, who is prepared to address the medical issues and can provide accurate numbers concerning decedents recovered and subsequently identified.

Community interest and media attention is heightened during an MFI. News briefings are essential but should be held after the family meetings and restricted to information that does not infringe on the rights of the victims or the work of the criminal justice system. It is wise to designate a Public Information Officer who will be the sole person authorized to communicate with the media.

International incidents, or those disasters that occur in one country but may involve the citizens of many nations, require special consideration. The legal jurisdiction will be the responsibility of the country where the incident occurred. However, many countries may have a strong interest in the investigative and forensic process. It is important to have representatives from those countries kept informed of the process. This may be done through the incident country's established agency to deal with foreign governments. It is also important to have interpreters available to facilitate communication, both for families, and foreign government representatives.

Pathology Protocol

The main pathologic procedures that will be performed on decedents include external examination, autopsy, and specialized autopsy. Decisions on which victims will be autopsied are based on prevailing laws and customs. Consideration should be given to the autopsy of all unidentified bodies, those without obvious cause of death, and a set percentage of remaining victims to provide meaningful statistical information. All bodies should receive as thorough an autopsy as is possible.

An external examination is a detailed viewing of the outside of the deceased's body, front to back and head to toe. Blunt and sharp force trauma, burns, patterned markings due to restraint, and explosive injury may all be seen on the skin of the decedent.

The autopsy incorporates the careful external examination with surgical incisions of the head and body to expose and evaluate internal organs. The internal organs are dissected, weighed, and examined individually. This internal examination may further delineate the extent of those injuries noted externally as well as preexistent natural disease.

Both types of examinations provide information as to the decedent's identity by revealing tattoos, unique physical characteristics, and old trauma and prior surgical scars. Additional testing such as X-ray and toxicologic studies may provide further important information, such as demonstrating occult fractures and quantifying alcohol or drug levels.

Basic anatomic findings in victims of a mass fatality often involve damage from blunt force, fire, and smoke inhalation. These injurious changes are carefully documented, with attention to their pattern, location, and areas of sparing. Interestingly, external burning of the body may not have caused death; rather the black, sooty material in the airway would indicate the person was alive in the fire and inspired toxic gases. Blood can be tested for the predominant toxic gas, carbon monoxide. Similarly, a decedent may appear relatively intact on the outside, with only a few scrapes and bruises, yet have fatal internal hemorrhaging from the aorta or liver.

In transportation disasters, special consideration must be given to those responsible for controlling the vehicle in question. The autopsy should attempt to answer questions on human performance and document visual problems, preexisting medical conditions with consideration of incapacitation and cause of death, a detailed description of stomach contents, injuries of the hands and feet due to possible contact and/or control of the throttle, yoke, or rudders, evidence of restraints, seatbelts, and the presence of any medications (Figures 4 and 5).

In an event the MFI involves a biologic, chemical, or radiologic agent, then special procedures may be required in the morgue. Examinations of the deceased should be limited and focused on obtaining fluids and tissues for evidentiary purposes.

Certain communicable or infectious diseases may necessitate the use of a more advanced biosafety level facility and specialized equipment such as high efficiency particulate air (HEPA) filter self-contained respiratory units (Figure 6). The Centers for Disease Control in Atlanta, Georgia, USA, can advise pathologists on appropriate autopsy techniques for individual biologic agents. State and local public health departments are also sources of information concerning prophylactic or postexposure antibiotic and/or immunization treatments.

Chemical agents may require specific decontamination procedures either in the field or in the morgue. Certain toxins require that the stomach is opened under a fume hood, while others require holding the body 24 hours prior to performing the

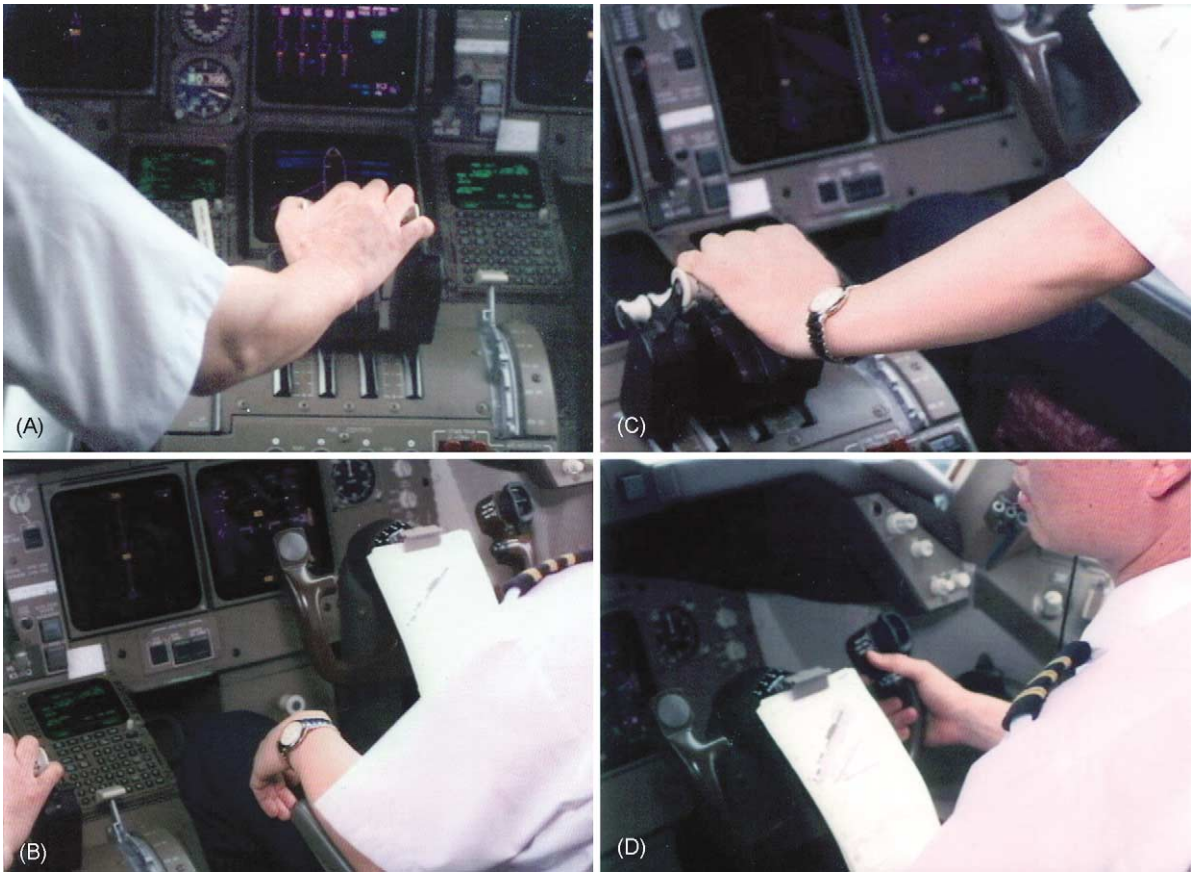

Figure 4 Flight deck of jet plane. (A) Captain demonstrates hand position when he is in control of the aircraft during take off and landing. (B) First Officer demonstrates hand position when at rest while the captain is in control to the aircraft. (C and D) First Officer demonstrates hand positions when he, and not the captain, is in control of the aircraft during take off and landing.

Figure 5 Hand of first officer from aviation accident. (A) The hand reveals avulsion of the left thumb. (B) X-rays of the same hand reveals underlying fractures of the middle and distal phalanges of the left thumb. Injuries on the hands of the flight deck crew must be carefully evaluated as they may indicate contact with the controls and who was in control of the aircraft at the time of the crash.

autopsy. Local hazardous materials teams are best suited to determine the necessary procedures. Radiologic agents may require decontamination and radiation monitoring with personal dosimeters for morgue workers. Environmental health agencies are knowledgeable about the monitoring for chemical or radiologic exposures that may occur in the morgue.

The documentation of the pathologic findings should be written and may be noted on an international DVI form or a local adaptation, such as the Pathology Examination Form of the Disaster Mortuary Operational Response Team in the USA.

Security

High-level security must be quickly established at the recovery scene, morgue, and family assistance centers. Personnel must wear specific identification badges with access privileges marked on each badge. Forensic pathologists may require access to all sites depending on their duties.

Law enforcement agencies should cordon crime scene perimeters at the disaster site. Curious observers must be prohibited from viewing the area. Families must be provided privacy at the family assistance center, away from media scrutiny. At all times the decedents must be treated with respect and confidentiality.

Critical Incident Stress Debriefing (CISD)

All MFI recoveries take their emotional toll on rescue and recovery workers. Sorting through endless carnage puts the pathology workers at particular risk.

Figure 6 HEPA-filtered self-contained respiratory unit. (A) Overview showing the black battery-operated filter unit and attached plastic air hose and mask. (B) Side view showing medical personnel donning the respiratory unit that brings the filtered air past the wearer's face beneath the face shield. This unit is worn by morgue personnel to control exposure to infectious airborne pathogens.

Therefore, it is imperative to realize susceptibilities to the psychological stress of the work. Mental health professionals can assist workers in coping with their emotions and recognize possible trouble signs of grief overload and exhaustion.

See Also

Autopsy: Procedures and Standards; Pediatric; Adult; **Aviation Accidents, Role of Pathologist**; **Crime-scene Investigation and Examination:** Major Incident Scene Management; **Death Investigation Systems:** United States of America; **DNA:** Basic Principles; **Identification:** Prints, Finger and Palm; Prints, Ear; Facial; **Injury, Transportation:** Air Disasters; **Mass Disasters:** Organization; Principles of Identification; **Odontology:** Overview; **Terrorism:** Medico-legal Aspects; Suicide Bombing, Investigation

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Organization

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Introduction

Definition of Mass Casualty

There are numerous definitions of a mass-casualty incident. The definition used here is an incident that requires a response beyond standard deployment. Thus, an incident in a small jurisdiction can be termed a mass casualty, whereas the same incident in a larger jurisdiction may be handled by the routine work force.

Organization

This article deals with the general organization of a mass-casualty incident response. As the above definition suggests, the deployment requirements for such a response are different from those needed for a regular crime scene. Medical aspects are part of that response and cannot be treated separately. They must be understood in the context of the general incident response.

Response Goal

The essential goal of a response is to restore life to normalcy. In a typical incident, this includes removing any dangers (hazmat (hazardous material), fire, etc.) and evacuating casualties and fatalities. Often in incidents occurring in a remote and unpopulated area, there is little or no disruption of daily routine. Treatment of the injured, fatalities and identification of fatalities, however, are still prerequisites to reestablishing normal living patterns.

In a terrorist incident, the primary objective of the perpetrator(s) is the disruption of normal life. Thus, in such an incident there is often political pressure on response authorities to restore the area to normalcy and defeat the terrorist perpetrator, even at the expense of meticulous evidence collection.

Command

A basic rule of mass casualty management is that one single organization, best determined as part of pre-incident planning, has ultimate responsibility at the scene(s). Although this article refers to the "scene" as a matter of convenience, it should be noted that one incident can have multiple scenes. This is true, for example, in an air crash in which parts of the plane(s) fall at a significant distance from each other. This happened, for example, on December 16, 1960, when United Airlines and TWA flights collided over New York: one plane fell in Brooklyn and the other in Staten Island. In such a case, each scene can have its own commander, who reports to an overall incident commander.

A currently popular management system is the incident command system (ICS), a flexible framework originally developed for use by fire departments and now with versions adapted to other incident responders. A benefit of ICS is its ability to expand or contract forces as incident needs change.

Relations with the Media

Relations with the media start before an incident. Local reporters should be given a basic understanding of mass-casualty emergency planning, so that they understand the basics of disaster response. It is difficult to give such background during a response. Many disaster plans include sample press releases prepared in advance. These releases have a basic text with blanks to be filled in.

During an incident the commander's spokesperson acts as the coordinator of various agencies' representatives. This includes hospitals, ambulance services, and forensic medical institutes. When organized properly, each spokesperson will provide the same approved information, but from his/her agency's work perspective, thus giving the media various sources to quote.

A basic guideline is that incident command should be as forthcoming with information as possible. If incident command cannot supply information, reporters will find material for their stories elsewhere. By its nature, the information provided by

representatives is slower than information received from private sources. The primary reason is that a spokesperson can never release news until it has been properly verified.

Information regarding criminal investigations should be withheld from the public, and the names of victims should not be released until families are officially notified. This can be time-consuming, particularly when next-of-kin are abroad or on vacation.

Press conferences should be scheduled regularly, particularly in an incident that continues for a long period of time. They should not be cancelled, even if there is no significant "news."

Photography, in the form of both video and stills, is part of news. Pictures can be provided to the press, but it is usually better to provide photo opportunities, provided they do not hamper the rescue and response effort.

It is a reality that media coverage (primarily the written press) determines the historical legacy of an incident and not what, in fact, really transpired.

Organizational Responsibility

Various organizations work under the authority of the incident commander, almost as autonomous units. If, for example, the incident commander is a senior police officer, fire and medical responders will work autonomously in their professional spheres. It is the function of the commander to coordinate the framework for working: this involves access/exit traffic patterns, unit staging areas, intergroup communications, and work priorities.

As a practical matter, there tend to be fewer problems of coordination between local police, fire, and the ambulance services, since they are accustomed to working together on a daily basis. More problems are encountered when external backup units are brought in, or with other groups who do not attend routine incidents.

On-Site: Nonmedical

First on Scene

The function of the first responder on site is to survey the situation and to report the situation to appropriate authorities. This is particularly difficult for a medical responder, who is sometimes tempted to begin treating the injured. Accurate reporting is the best way to insure the arrival of the appropriate number and type of responders.

It is common for there to be a certain amount of confusion in the initial postincident period of response, as forces arrive, and a command structure is established.

Police Functions

One of the first tasks of police at a mass-casualty incident is to establish traffic patterns, so that other emergency vehicles can have relatively unhindered access to the area, then rapid exit to destinations such as hospitals. This includes designating parking areas, so that the vehicles of responders do not hinder traffic. An extension of this function is the rerouting of general traffic away from the incident area, with appropriate notice to the public, usually by radio and mobile phone announcements.

Another police task is to cordon off the incident area, limiting access to authorized personnel only. The objectives are to allow efficient work and to provide basic security of information and evidence. Closing off the immediate area also prevents unscrupulous media representatives from conducting interviews with those victims needing or receiving medical attention. This task is extremely difficult, since it also involves tactfully removing volunteers who were essential immediately after the incident took place and witnesses who need to be interrogated. There is also not an absolute list of responders who are authorized to be present; the list varies according to the progress of the response. For example, after victims have been removed from the site, only a small medical contingent is necessary – and then for first aid.

Additional functions in which police often play a role are incident reconstruction (in the case of specialized incidents such as aviation, often delegated to agencies established for the purpose) and locating out-of-area relatives through law enforcement liaison channels.

Fire Functions

The obvious duty of the fire department is to extinguish all fires. This includes notification to responders that particular areas are safe for entry and monitoring the scene to ascertain that no additional fires break out (e.g., in cases where there is a fuel spill).

In some jurisdictions the fire department is assigned a role in first aid and extrication, since they normally perform these functions.

Staging Areas

An efficient organizational plan is to divide the mass-casualty area into two or three zones. The inner zone is that area of direct response. Only active responders are allowed into this zone to minimize confusion and allow the least interference with work. In many cases the number of workers allowed in this zone is pragmatically restricted by space. Depending on the size of the incident, one or two outer holding zones are

established; it is there that responders wait with their equipment before they are told to move forward.

Some disaster work is sequential and not simultaneous. Fire fighting, for example, often precedes the introduction of medical responders into the affected area. Dealing with the injured precedes handling the dead.

Evidence

A mass-casualty site is a potential crime scene. One approach is that it should be considered a crime scene until proven otherwise. How can an earthquake, for example, be considered a crime scene? There have been numerous examples of the collapse of a building due to the use of substandard construction materials.

Suicide terrorist attacks should also be treated as a crime scene, even though the bomber has been killed. In the vast majority of such incidents, there is a group of people who manufactured the explosive device, planned the incident, and transported the bomber. Proper evidence collection will assist in their arrest and prosecution.

Although medical necessity certainly justifies moving evidence, photographic recording of the scene as early into the incident as possible can be a major help in incident reconstruction.

Other Functions

A variety of nonemergency functionaries have roles at a mass-casualty incident. These range from insurance adjustors to structural engineers. Each function has to be evaluated independently in terms of entry to the scene. The structural engineer might be needed immediately to decide if a building is safe to enter; the insurance adjustor can be admitted much later.

Disaster Myths

There are many myths and misconceptions about behavior after a mass-casualty incident. Taking these myths into consideration during planning results in a more realistic response.

Rarely, for example, is there panic. Victims can be selfish in their desire to save themselves, even to the extent of pushing others aside, but it is only when there is no clear escape route that they sometimes make irrational (i.e., "panic") decisions.

Contrary to popular conception, victims who are not seriously injured are not helpless. Many save both themselves and others before professional rescuers arrive. This is also true for passers-by, who often play a critical role in rescue before trained personnel come to the scene. Part of planning is the orderly replacement of volunteers by professional staff.

Another myth is that of looting, the open and wanton stealing of property. This is an extremely rare phenomenon. Much more common is quiet and surreptitious theft, often within the definition of souvenir hunting.

On-Site: Medical

Ambulance Deployment

There are two approaches to routine ambulance deployment. One is to station ambulances at a dispatch center from which they are sent to various incidents. Another is to park ambulances in neighborhoods, often at the house of the driver, who is dispatched through a communications network. The latter system has the advantage of quick response due to dispersal throughout a city; in addition, the simultaneous arrival of numerous ambulances is often counterproductive, since they cannot all receive patients at the same time.

Another idea now being tested is the use of motorcycles carrying limited supplies to a mass casualty site. These motorcycles generally arrive before regular ambulances. Negative considerations in this approach are the minimal amount of time saved and lack of equipment. Another point of concern is that ambulances arrive and quickly depart from the scene; motorcycles are parked, thus complicating scene management.

Victim Treatment

In a mass-casualty situation the basic goal is "to do the most good for the largest number of people." This differs from standard medicine, where the goal is to save lives. In practical terms, when the injured outnumber the medical staff available, doctors sometimes have to forgo the intensive treatment of a patient who might otherwise be saved, so that more patients can be treated. This change in medical emphasis is often a root cause of postincident psychological trauma for medical responders.

A second goal is the identification of the dead (disaster victim identification (DVI)), which requires cooperation between police and legal–medicine personnel. From an organizational perspective, the police are often tasked with collecting background information about the disaster and antemortem information. Forensic medical personnel are tasked with collecting most postmortem information and comparing it for identification purposes. Needless to say, there must be coordination between the two

functions, so that there is an emphasis on the collection of antemortem information corresponding to medical needs.

In popular language, there is sometimes confusion between mass casualty (injury) and mass fatality (death). It is very common that a large incident will include both casualties and fatalities.

Triage

A triage or examination area is established for the rapid examination of victims extricated from a disaster site. Such an area is located close to, but at a safe distance from, the mass casualty incident. In triage a priority evacuation system can be established when victims outnumber ambulances, allowing for the most seriously injured to be evacuated first. A common technique in triage is to fasten commercially available preprinted labels to victims, indicating the priority of their evacuation.

When the number of ambulances available equals or exceeds the number of victims, the "scoop-and-run" system is often used for evacuation. In such cases, victims are removed from triage in the order they arrive. Prioritization of treatment becomes a hospital function.

It is common for medical staff to attempt rudimentary stabilization of patients in the triage area, before they are transported to hospital.

Medical Precautions

Mass-casualty sites often include numerous medical hazards, ranging from sharp metal edges to bodily fluids. Potential responders should maintain up-to-date inoculations such as tetanus and hepatitis. In addition, they should be supplied with protective clothing, often of the disposable type.

There is no one kind of protective clothing that is appropriate for all hazardous situations; thus, supply must be both adequate and flexible. A general guideline for quantity of all response equipment is a sufficient supply until additional materials can be obtained. In most cases this will include 24/7 emergency arrangements with commercial sources. When sharp edges (e.g., bent and torn metal) are present, thick-soled shoes and heavy gloves are recommended. In hazmat incidents, sometimes an entire closed-system breathing apparatus is required.

Record-Keeping

A record is kept of victim dispatch to hospital. This will necessarily be incomplete due to those who are less seriously injured being evacuated independently, but it will be of major assistance in bringing order to the evacuation procedure. These records should be compared and verified with hospital reception records.

In many cases hospitals record the reception of patients by their type of injury and the treatment needed. Records should always include the incident involved, so that victims of the mass-casualty incident can be separated for record-keeping purposes from other hospital patients.

Decontamination

There are numerous types of hazmat mass-casualty possibilities, ranging from commercial industrial accidents to terrorist chemical attacks.

In many cases it is necessary to decontaminate exposed victims. The decontamination procedure varies according to the contaminant. One general rule with many substances is that the exposed victim has to be washed and given uncontaminated clothing. The dead must be decontaminated externally and sometimes internally as well.

Victim Identification

There is no professional rule concerning the presence of forensic pathologists at the mass-casualty site. Most pathologists want to visit the site to gain a first-hand impression of what happened. Others rely on police reporting. In any event, the functions of victim identification teams at the scene are to photograph all bodies and property where they were found, then remove them to a forensic institute. Victim identification is not done on-site.

On-Site: Nonmedical

Communications

Communications gear should be accessible to all responders. Senior coordinators should have equipment enabling contact with counterparts in other agencies (for example, both fire to police, and fire from jurisdiction A to backup from jurisdiction B).

Studies show that the most significant problems in response almost always revolve around issues of communications.

Communications systems should have backups. Mobile phone lines notoriously become overloaded and nonfunctional. Batteries also fail. One communication possibility that should not be overlooked is a point-to-point landline telephone, from, for example, the command center to the commander on site (usually a short distance away). This provides excellent security of conversation while at the same time providing a line that is always available.

Equipment

A reality in disaster response is that available equipment rather than predetermined planning usually determines a unit's function.

One successful approach to organizing response equipment is advance packaging for a specific function, with an officer in charge of logistics for transporting the packages. In pragmatic terms, it is assumed that a police crime scene unit is responsible for handling the mass-casualty site (similar to their routine work). Their equipment would be divided into various suitcases – photography supplies, interrogation forms, etc. The unit logistics officer would be responsible for transporting the suitcases, either by individual police officers or in a larger shipment.

Mass-casualty equipment should be prepared in advance and checked periodically. An ambulance, whether in a single or mass-casualty response, generally deals with only one patient. Many other functions, however, deal with a situation much larger than routine and need appropriate equipment in larger quantities.

Responder Identification

It is helpful if all responders wear uniforms and/or vests to identify their function and command status (e.g., supervisor) at a mass-casualty response. Vests have the added advantage of being specially designed with pockets to carry essential equipment such as communications gear or writing tools.

At later stages of the incident it is recommended to use badges changed daily to control entrance into incident response facilities.

Volunteers

On-site volunteers can be classified according to groups. Other than individuals, professionals, or otherwise, who chance to be near a mass-casualty incident, there are volunteers who are members of nongovernmental organizations (NGOs), and those who are an auxiliary force within the framework of an official government group (e.g., volunteer fire). NGOs and official volunteers are often motivated to offer their services both from charity and excitement or importance.

Psychological Reactions

Posttraumatic stress disorder (PTSD) is a common psychological reaction to mass-casualty incidents. Its symptoms can start at the scene, but they are much more likely to develop afterwards. Some response agencies station a clinical psychologist at a mass-casualty site to monitor the behavior of personnel; this has both mental health and quality-of-work benefits. In any event, postincident debriefings are held several days later, after responders have pondered their actions. At these sessions psychologists can detect reactions beyond the norm.

Job burnout has some symptoms which are similar to PTSD, but the problem and its treatment are significantly different. It is important that a trained psychologist makes this differentiation.

Off-Site

Information Bureau

The purpose of an information bureau is to coordinate details about an incident and to provide relevant information to various customers. An information bureau is best staffed by representatives of numerous organizations, taking into account foreign-language requirements. When run properly, the information bureau will accept a maximum number of telephone and personal inquiries, so that other organizations can carry on routine and emergency functions as far as possible (e.g., an airline whose aircraft has crashed still needs to make other flights; an ambulance service needs lines free to accept emergency calls unrelated to the mass-casualty incident).

Casualty Bureau

A casualty bureau is a subset of the information bureau. It is set up to centralize the collection of personal information about the victims of an incident.

One specific function of an information bureau is to assist families to locate injured or missing relatives without overloading hospital telephones. This is done by centralizing all hospital patient lists and relieving hospitals of the burden of answering inquiries.

Sometimes a casualty bureau is confused with a fatality bureau. This happens because, after all hospitalized victims are identified and reunited with family, the emphasis of work turns to the identification of fatalities.

When dealing with fatality inquiries, telephone staff are equipped with forms to be filled out concerning the relationship and contact numbers of those making inquiries. This will later be of assistance to facilitate possible police requests for antemortem data.

Victim Identification

DVI is the positive comparison of antemortem and postmortem information that is of sufficient significance. An institute of forensic medicine is usually in charge of DVI, even when the identification is

apparently "obvious." This is necessary for subsequent legal proceedings.

The most common organizational system for DVI is that advocated by Interpol. Antemortem information is collected on forms printed on yellow pages. Postmortem information is collected on pink pages printed with the same questions. Administrative correspondence is done on white paper. (The forms can be downloaded from the Interpol website: www.interpol.int.)

A large chart is usually prepared showing the mortuary body number in a center column. On the one side are the various types of antemortem information, with a check mark to show what has been collected. On the other side are similar columns for postmortem information. One can then see at a glance what further information must be collected. For example, if there are no postmortem fingerprints, no antemortem prints are necessary. Finally, there is a column for the victim's name when it has been determined. Using a wall chart can be a positive factor in sustaining morale, allowing responding workers to see progress in identifications.

There are numerous computerized information comparison programs available. These are primarily for dental information, but general programs are also to be found. Experience has shown that input time and uniform terminology usually render these programs impractical. One manual method to cope with information management is to divide files into groups (adult/child, male/female, etc.). Mistakes (such as age) can be corrected by periodic regrouping.

In some mass-casualty plans, a single significant type of identification (e.g., fingerprints or odontology) is sufficient to assign a name to the deceased. In other plans multiple types of identification are preferred to prevent possible error.

In the USA nine disaster mortuary operational response teams (DMorts) have been established under the disaster response plan of the Federal Emergency Management Agency (FEMA). These teams include victim identification capabilities ranging from forensic specialties to morticians and clerical support. They stand ready to give support to local jurisdictions or to assume responsibility in federally recognized disasters. The teams are modular; part or all of the DMort infrastructure can be activated as a situation requires.

Notification of Death

Notifying next-of-kin about the death is both a humanitarian and legal function. From the viewpoint of the latter, family should be requested to acknowledge receipt of the notification.

Some emergency plans call for the presence of first-aid personnel and equipment at forensic institutes when notifications are made. In many instances those notifications include viewing the body of the deceased, which increases psychological trauma.

Burial

Burial (or cremation) of the deceased is not a part of the incident response. Identified bodies are released into the custody of the legal next-of-kin, who are then responsible for making all further arrangements. After a body is identified and found to be not from the country of the incident, it is "repatriated."

Memorial Services

It is common for the incident command to arrange for nonsectarian or multifaith memorial services, as is deemed appropriate. According to circumstances of the incident, such ceremonies can take place relatively soon after the incident and subsequently on annual anniversaries.

See Also

Mass Disasters: Role of Forensic Pathologists; Principles of Identification

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Principles of Identification

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Introduction

Mass incidents may bring challenges to the investigating authorities. In addition to the issues of identifying the victims, the police may be faced with a homicide investigation and the handling of the scene, and the postmortem examination must proceed with the assumption that a criminal prosecution is a possibility. In performing an autopsy the pathologist must answer a number of questions, in particular who the deceased was and how he/she came to die. There are a number of methods by which a body may be identified, and these will be discussed in turn. These criteria apply whether the incident is a true disaster or brought about by humankind, such as conflicts or acts of terrorism.

At any major incident the person who has the duty to investigate the death legally – be it the coroner, medical examiner, procurator fiscal, or examining magistrate – will need to liaise with other experts in the process of identification. A supervising pathologist should be identified to act as the person who conducts and oversees the autopsies to be performed and to liaise with the coroner or equivalent. A senior identification manager (SIM), a senior police officer, should also be appointed. These people should all be part of the Identification Commission, a team that is standard in Interpol countries. The Commission includes the Incident Commander, SIM, supervising pathologist, coroner, or equivalent position and other police officers, such as family liaison officers, whose duty is to confirm the identity of the remains. Ideally the Commission should meet daily.

The International Committee of the Red Cross has drawn attention to the duty of governments to help identify the victims of wars and internal conflicts in its project The Missing. The principles that apply to the identification of the victims of an air crash also apply to the victims found buried in a mass grave.

Basic Procedures

Following any mass incident a system of logging bodies at the scene should be in place so the continuity of any body can be traced. The same applies to any body parts. The bodies are placed in a body bag with identification labels both inside and outside. The bodies are then brought to the mortuary, whether it is a temporary mortuary or an established facility, again preserving continuity. The bodies are photographed with the identification label and the clothing removed and searched. Consideration for collection of trace evidence and/or radiological examination should be made before any clothing is removed, e.g., if explosives are suspected as a cause for the incident. The body should be cleaned down and re-photographed. Radiological examination can also be performed at this stage. The body can then undergo the autopsy, documenting features for identification as well as determining the cause of death. At the autopsy, samples for DNA analysis should be collected, as well as for other analyses such as histology and toxicology.

Once the autopsy is complete, the body can undergo fingerprinting and footprinting, if necessary. These procedures can, if desired, be carried out before the autopsy after any necessary trace evidence has been collected. Following the autopsy the odontological examination can also take place, including dental radiology. Once the body has been autopsied and other ancillary procedures have occurred, it can be reconstructed and embalmed if required.

Methods of Identification

Identification criteria can be divided into primary and secondary identification criteria. The traditional methods of identification have been visual. They cannot now be considered as the best methods and are prone to inaccuracy. These methods are now considered as secondary identification criteria.

Primary Identification Criteria

Fingerprints Fingerprints, if not destroyed , are easy to obtain and allow for accurate identification. Therefore, fingerprints should always be collected. They then need to be compared with preexisting fingerprints. These can be obtained from records if present, or by obtaining latent fingerprints. Fingerprints are taken from all citizens in some countries and in others when they have committed a criminal offence. Other groups, such as military personnel, may have fingerprint records. In other cases latent fingerprints may be obtained. In these latter cases, where there is a presumed identity article known to have been used by the deceased such as a shaving can, deodorant can, the car driven to the station, or similar objects that are known to have been handled, this can be examined for fingerprints and then compared with those taken from the body. As fingerprints are considered a unique identifier, fingerprints are an objective primary identification criterion. Similarly, footprints could be used if for some reason a record is kept, as is the case with some military personnel, or latent

footprints could be obtained. However, consideration must be given to the problems created when the victim's home has to be searched and examined for these latent prints, which may be distressing to the grieving relatives. One issue that arose in the "Marchioness disaster" in the UK (an incident where two boats collided on the river Thames in London resulting in the loss of many lives) and led to a judicial inquiry (the Clarke Inquiry) was how fingerprints should be obtained from a body. In the Marchioness disaster a number of hands were cut off and sent to a laboratory. When this was discovered, it caused a significant outcry from the relatives and led to the establishment of a public inquiry in England into how victims should be identified following major disasters. The removal of hands or digits should never be carried out unless there is no alternative method of identification.

Odontology Odontological examination of every victim should be considered, including radiological examination. Teeth are the most resilient structures in the body and therefore can survive conditions where other features are destroyed, whether by trauma, fire, or decomposition. Odontological examination has been one of the most employed methods for identification for many years. Although DNA analysis has now come to be a key feature of mass incident identification, dental identification remains important. As with other methods of identification, antemortem data are required for comparison and the ability to obtain dental records will determine how useful the method will be in any disaster. Furthermore, with improvements in dental health, no dental treatment may have been carried out. Therefore it is possible that this method of identification may not prove as useful as might at first have been anticipated. The removal of the jaws from the body for odontological examination should be considered carefully before being undertaken, as it may be distressing to the relatives. At present with appropriate antemortem dental records, forensic odontology provides a rapid method of identification which does not require the laboratory time that DNA analysis currently takes. Forensic odontology can also provide anthropological data and age estimation from the eruption of teeth, or by histological examination.

DNA analysis DNA analysis has made a significant contribution to identification since its development in the 1980s. At the autopsy, tissue should always be collected for analysis. Traditionally blood or muscle has been used but any tissue can be analyzed. In intact bodies a buccal scrape can be used; this is the standard method by which those arrested for criminal offences are analyzed. As has already been described, teeth are often the least damaged of tissue and can be used to obtain DNA for analysis. DNA analysis has two roles in mass incidents. These are in primary identification and in allowing dismembered bodies to be reunited. This latter role shows the power of DNA analysis but also raises questions about how far investigation is required for the reuniting of remains. This may depend on cultural and religious requirements as well as legal duties. Mitochondrial DNA may be an available resource when nuclear DNA has degraded, though only the maternal line will be identified.

The ability to store material for DNA analysis now means that where there are victims who cannot be identified, particularly where there is disruption or fire damage of bodies, as in the terrorist incidents of September 9, 2001 in the USA, subsequent tests in the future may become possible. As DNA technology advances, degraded or damaged DNA-containing tissue may become identifiable.

Secondary Identification Criteria

Visual identification Traditionally a relative or close acquaintance would carry out the legal process of identification. This is still the commonest method of identification in single deaths, where the issue of identification is not in real dispute. However, there are many problems with visual identification in mass incidents and it should not be considered a primary method of identification. Relatives or other people who knew the deceased may not be available, but even if they are, incorrect identification of victims is well recognized with visual identification. Visual identification must be considered as a subjective method of identification. Therefore, if visual identification is to be used it should be used alongside another objective scientific criterion. Viewing of the body for grieving purposes by relatives is a separate issue and may be possible following confirmed identification.

Clothing and other artefacts The clothing and jewelry worn by the victim may be identifiable by a relative as those worn by the deceased. This provides clues, but should not be considered as an objective criterion. Fashions may be copied and at some incidents, such as where sports spectators are killed, many people may be wearing the same shirts in support of their team. Similarly there are problems with other possessions. Personal items may be duplicated and the possibility of someone carrying another person's possessions cannot be excluded. In at least one mass incident a pickpocket had stolen a number of wallets before he died in the incident. Personal possessions should only be considered as secondary identification criteria.

Body features The sex, height, weight, hair color, and eye color are all useful pointers to the identification of the victim, but cannot be considered primary objective scientific criteria. Body scars, deformities, and tattoos should also be considered as pointers to identification, but it will be unusual for them to be considered objective criteria. Tattoos are said to provide possible unique identification, because their exact structure and position on a body could not be replicated, but to confirm this requires firm corroborative evidence, such as a good-quality photograph or the tattoo artist's professional opinion that he/she carried out the tattoo and these data are unlikely to be available in a mass incident setting.

Autopsy findings The use of a full autopsy in mass incidents will vary between jurisdictions. As well as establishing the cause of death, the internal examination may provide clues to identification if previous surgical procedures have been carried out or implants such as cardiac pacemakers inserted. However, these cannot be considered primary identification criteria, unless they have a unique identifying number, in which case the number may be able to be checked with medical records or the manufacturer, when it can then be considered a unique identification criterion.

Radiology Radiological examination may be performed as part of the autopsy. Radiological features such as implants or frontal sinus structure may be present which allow for identification. This will require a comparison of antemortem records, which are required for objective identification and may not exist, or be difficult to obtain.

Forensic anthropology Where there has been disruption of bodies or the remains have partially or completely skeletonized, forensic anthropology can provide useful information. Examination of the skeleton can allow an estimation of stature, build, and age of the victim. Along with the determination of sex and ancestry, this allows for exclusion of some victims and inclusion of others, refining the search for victims. With disrupted or skeletonized bodies, commingling of remains is a common problem and examination of the skeletons can determine the minimum number of victims as well as refining the criteria for identification. Typically, examination of the skeleton will only provide secondary identification criteria, though unique features, such as a previous amputation or unusual pathology, may allow more definite identification, especially in a closed incident.

Conclusion

Many methods of identification are available. Traditional methods such as visual identification are unreliable. Secondary identification criteria provide useful intelligence to narrow down the number of potential victims to be related to an individual body, but formal identification should be based on fingerprints, odontological examination, or DNA analysis.

See Also

Court Systems: Law, Japan; **Crime-scene Investigation and Examination:** Recovery of Human Remains; **Terrorism:** Suicide Bombing, Investigation; **War Crimes:** Site Investigation

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Mass Disasters, Aviation *See* **Aviation Accidents, Role of Pathologist**; **Injury, Transportation:** Air Disasters

Mass Disasters, Scene Investigation *See* **Crime-scene Investigation and Examination:** Major Incident Scene Management