



Management of

Fragmentary Human Remains in

Mass Disasters and Catastrophes

Asia Pacific Medico- Legal Agencies (APMLA) is a network of 20 forensic medical institutions from 18 Asian and Pacific nations. The APMLA was established in 2012 in Indonesia. The network is focused on:

- peer to peer cooperation and preparedness for mass casualty events and the;
- promotion of improved forensic medical services for better community health and justice systems.

The APMLA's inaugural Chair was Dr Nak Eun-Chung, Chief Medical Examiner, Republic of Korea National Forensic Service and National Disaster Victim Identification Service (DVI) Director. Current Chair, Dr Mohd Shah Mahmood, Director of the National Institute of Forensic Medicine in Malaysia was elected in September 2015.

The establishment of a geographic network of forensic medical institutions provides an essential link for agencies with a commitment to strengthening humanitarian forensic medical capacity and fostering robust medico-legal systems at a regional level. The APMLA acts as a facilitator and advocate in scoping and identifying the scale of capacity development required in participating emerging economies and supporting the regional partnerships between forensic medical organizations, donor agencies and nations that have a clear commitment to enhancing their forensic medical capabilities.

The formation of a multi-lateral network of Forensic Medical Agencies facilitates the sharing of forensic medical and scientific knowledge, collaborative DVI response, training, practice and assistance at a multi-national level within the region in addition to peer-to-peer learning, opportunities for capacity development projects and resource development for forensic medical infrastructure in participating nations.

Representatives of APMLA institutions meet annually and at allied conferences. The network has formed a number of work groups which focus on particular aspects of forensic medicine. This publication is the result of the work of one such APMLA Work Group.

Contents

Contributors	p.4
The issue	p.5
Definition: Fragmentary human remains	p.5
Introduction	p.6
Procedure	P9
1. Recovery and early management of fragmentary human remains	
1.1 Overview	
1.2 Recovery	
a) At the scene	
b) At the mortuary during postmortem examination	
1.3 Labelling	
1.4 Storage	
2. Identification of fragmentary human remains	P.12
2.1 Overview	
2.2 Triaging for identification	
2.3 Documentation	
2.4 Identification	
3. Final release of fragmentary human remains	p.14
3.1 Re-association	
3.2 Disposal	
4. References	p.15

Contributors

1. Dr. Jayanie B. Weeratna

Forensic Odontologist, Institute of Forensic Medicine and Toxicology, Colombo, Sri Lanka

2. Assistant Professor Rijen Shrestha

Forensic Pathologist, Department of Forensic Medicine, University of Kathmandu, Nepal

3. Dr. Daniel Augustinus

Forensic Odontologist, Medical Operational Department, Indonesian National Police, Indonesia

4. Professor Stephen Cordner

Professor of Forensic Pathology (International), Monash University;
Head, International Programs, Victorian Institute of Forensic Medicine, Australia

External Reviewer

The contributors gratefully acknowledge the substantial contribution of:

Bradley J. Adams, PhD, D-ABFA

Director of Forensic Anthropology
Office of Chief Medical Examiner, New York, United States of America

Edited by

Dr. Liz Manning PhD

Manager, National and International Programs
Victorian Institute of Forensic Medicine, Australia

Acknowledgements:

- i. **Janine Krochmal**, Librarian, Victorian Institute of Forensic Medicine for assistance with references
- ii. **Shuala S. Martin**, Regional Forensic Coordinator - Sri Lanka and Bangladesh, International Committee of the Red Cross (ICRC), Sri Lanka (for general guidance and support)

Neither the external reviewer nor those acknowledged bear any responsibility for the contents of this document. That responsibility belongs to the APMLA and the contributors.

The issue:

The principles of managing and identifying human remains in disasters and catastrophes are well documented in readily available guidelines (1,2). Anyone who has been involved in the management of human remains in such circumstances knows well that there are large numbers of issues which need to be addressed in the operation generally, and in specific cases, where guidance is not available. The APMLA has decided to identify as many of these issues as possible, and over time to develop guidance to deal with them.

The need for this document arose from the experience of the contributors dealing with fragmentary remains in various mass fatality disasters. The contributors are well aware that in some contexts, most notably in that of the Twin Towers outrage on 11 September 2001, the focus of human remains management has been on the identification of fragments of human remains using the most sophisticated molecular techniques available. As culturally necessary and laudable as this is, such an approach is not available in most contexts with which the contributors are familiar. In addition, even if such an approach was available, it may not be used for a range of reasons such as cost or ease of availability, when these are weighed against an assessment of the necessity of the approach to achieve the aims of the operation. Furthermore, in most instances during the initial stages of the recovery of remains, emphasis would be given to bodies and larger body parts and not necessarily to fragmented remains.

However regardless of size, all human remains must be handled with respect. This document is an attempt to provide advice about the management of fragmentary human remains in disasters and catastrophes where DNA techniques, for a range of reasons, will not be applied to their identification.

Definition: Fragmentary human remains

Unidentified pieces or parts of a human body, with greater or lesser chance of being identified are referred to as “fragmentary remains”. The fragments or pieces are not physically attributable to any particular individual, often because of separation from the remainder of the body.

Fragmentary remains can range in size from large to tiny. Some will have higher identification potential than others. DNA analysis is the only means by which fragmentary remains can be re-associated. Ultimately by the end of the operation fragmentary remains include all unidentified body parts.

Finding all fragments is complicated because they are often mixed with other remains or material at the scene.

Introduction

Mass disasters can be natural, accidental or man-made and result in loss of human lives and damage to property. Catastrophes are disasters on a huge scale. The human remains recovered can be

- Intact bodies (commonly referred to as bodies); or
- clearly identifiable parts of a body which, if the rest of the body is available, could be re-associated with that body (commonly referred to as “body parts”); or
- unidentified pieces or parts of a body, with greater or lesser chance of being identified (referred to as “fragmentary remains”.

These categories overlap to some degree. Obviously, disasters which involve explosions, high velocity impacts such as plane crashes, collapsing buildings or fire, result in greater degrees of disruption, including fragmentation of the bodies. The resulting unidentified (including fragmentary) remains may be commingled, or mixed with debris, which complicates their management.

Therefore, in this document ***fragmentary remains*** means fragments or pieces of human bodies in circumstances where the bodies are not intact and the fragments or pieces are not physically attributable to any particular individual. Such remains are separated from their host and often mixed with other remains or material at the scene. Examples of unidentified fragmentary remains can include small (or even larger) pieces of subcutaneous fat, muscle and/or connective tissue not anatomically identifiable as coming from a particular part of a body, or small pieces of anatomically anonymous skin or bone. DNA analysis is the only way to re-associate fragmentary remains. Larger unidentified body portions may initially be included in the definition, but these are usually, and sometimes early on, able to be physically re-associated with their host body.

The decisions that are made at the initial stage of the management of fragmentary human remains can have long lasting medico-legal consequences and significantly affect families. Therefore, it is important to define the ultimate goal of the operation at the commencement of the body management process. Generally, the overall goal is to identify all the people who died in the disaster or catastrophe. Identifying all the human remains, including fragmentary human remains, could be a part of that overall goal, or could be required because it is regarded by the community as an important component of the respectful management of the disaster.

Therefore, the ultimate goal(s) of the operation could be, to the greatest extent possible, to:

1. **identify all the individuals who have been killed** and/or
2. **identify each and every fragment of human remains (3)**

Finding out who has been killed in the disaster can be undertaken without necessarily identifying every fragment of human remains. Conversely, identifying every fragment may not identify all those who died. In the 9/11 attack in New York, it soon became clear that identifying the dead bodies, parts of bodies and even fragmentary remains would not provide the full list of those who were killed. The authorities had to identify many of those who had been killed by circumstantial means: X worked in the Twin Towers, left home that day to go to work, was seen by a survivor to enter the Twin Towers 15 minutes before the plane was flown into them, has not been seen since, and there has been no evidence of any access to bank accounts or of other activity initiated by X since. It was therefore reasonable to conclude that X is dead.

The authorities in New York took the decision to try and identify every single fragment of biological material in the rubble – “we will never stop”¹. The aim in relation to the fragmentary remains was to find a biological marker of as many victims as possible because it was deemed culturally necessary². This also enabled remains of individuals to be brought together, resolving issues of commingled remains, even if they were tiny in size. How a recovery operation is managed, especially in relation to unidentified (including fragmentary) remains, depends on prevailing ethical, social and cultural values along with the availability of human and financial resources.

Virtually every aspect of the management of human remains has ethical implications. This includes the management of fragmentary human remains. Social, cultural, and religious attitudes and customs in the affected society all play a significant role in determining the management process. Practical considerations will also play a role. Identifying fragmentary remains will not be possible if there is no DNA laboratory capacity available, or it is not easily available or is too expensive.

There will be some contexts, perhaps those where socially a strong communitarian culture exists, where the need to identify each and every minute fragment of human tissue will be felt less acutely than in others. For example, one can imagine the possibility of a large bushfire (or wildfire) catching a family in a house in which all members of the family and their pets are killed, possibly having retreated and

¹ Dr Charles Hirsch: Personal communication

² 2,753 people died in the Twin Towers disaster in New York. Recovery of remains was completed by May 2002 with the removal of 1.7 million tons of debris and the recovery of 21,906 separate pieces of human remains. Only 1,637 identifications were finalized as at September 2015. In other words, the remains of about 1,116 people were effectively completely destroyed by the effects of the disaster.

gathered closely together in one room. The forensic issue is one of commingled charred human remains, many of which are fragmentary, as defined in this guideline. Even so, representatives of the family could properly decide that they want all members of the family to be buried together, perhaps even with their pets, eliminating the very long (and even then probably incomplete) exercise of separating, individualizing³ and then re-assembling as many as possible of the identified fragmentary remains.

³ This will either be by physical means or DNA profiling. In circumstances of charring very many of the fragments will not be identified.

1. Recovery and early management of fragmentary human remains

1.1 Overview:

The recovery procedure described here can be carried out after the completion of the initial dead body recovery process. In many disasters it will be completely beyond the resources or capability of the operation (especially if the disaster is large in terms of numbers or area), to undertake this additional recovery procedure. If this subsequent recovery procedure is to occur, its main aim is to recover all the human remains which have not been recovered by the initial search and rescue teams or by those recovering the dead bodies and body parts.

Thus the remains that are the focus of the subsequent search are smaller. Most will be fragments which cannot be identified as necessarily human; or if they appear to be human, cannot be identified as belonging to a particular part of the body; or if they can be identified anatomically, cannot be physically associated with a particular body. Usually they are mixed with rubble at the scene. They can also be commingled with other body parts or fragmentary remains, or in some situations commingled with non-human animal remains.

There are several challenges in conducting this kind of a search and recovery operation. The fragmentary remains are small, commingled with rubble, may have been disturbed during search and rescue procedures, and the search may be complicated by environmental conditions. As mentioned above, in some disasters, the fragmentary remains could be the only part that is left of a particular body. Therefore, as with the 9/11 disaster in New York, it may be culturally important to recover all such remains from the scene.

This subsequent search operation can be performed in parallel with, but separate from, the search operation for unassociated personal effects (UPE). That is, personnel that are involved in collecting UPE should be separate from the team undertaking the fragmentary remains recovery operation. The success of the recovery will depend on the experience of the personnel involved in the search operation as well as the strategies used in processing the scene.

1.2 Recovery

Every disaster is unique and the search operation for fragmentary remains, if there is one, needs to be designed accordingly. However, in any operation the same basic principles should be applied.

a) At the scene

During the subsequent search operation to recover the fragmentary remains, grids that were used in the main search operation when intact dead bodies and body parts were retrieved should be followed. In addition, before recovering fragmented remains it is essential to undertake a systematic photographic recording of the scene.

When recovering the remains, the possibility that the remains are human should always be given the benefit of the doubt. Forensic pathologists and anthropologists can often identify non-human remains, and the involvement of these experts in the recovery process reduces the number of non-human fragmented remains reaching the mortuary. However, in a mass disaster experienced anthropologists and forensic pathologists may not be available because they are in short supply and required in the mortuary for formal body identification procedures. Medical trainees or students in forensic sciences and anthropology, for example, are amongst those who can recognize fragments of biological material and who could be employed in this task.

Fragmentary remains collected at the scene should be labelled with a grid reference, and taken to the mortuary for appropriate storage.

b) At the mortuary during postmortem examination

Some fragmentary remains may also be collected at the mortuary during the examination of individual bodies/body parts. For example, there may be commingled remains (Type I commingling (4) - separate human remains are mistakenly grouped together in a recovery bag at the disaster scene for example: two or more bodies, or parts of bodies, having been placed in the same bag – a common breach of DVI procedures) and fragments which cannot be properly associated (by physical means – for example matching two halves of a divided limb or long bone) to one or other of the bodies in the bag.

Such remains should be taken from the body bag, packed separately and re-numbered with the grid number for the recovery site. It is important to maintain proper documentation of remains that have been removed from the body bags. Larger and anatomically recognizable body parts with high identification potential will be dealt with according to well established procedures. The remains with low

identification potential including fragmentary remains should be recorded in a separate log and handed over to the Mortuary /Identification Team Leader for appropriate storage.

1.3 Labelling

Fragmentary remains recovered at the scene should be labelled according to the scene grid plan. Labelling individual fragmentary remains may or may not be necessary and a policy for this should be determined at the outset. However, for subsequent investigative purposes, use of the grid number links the fragmentary remains to the place of recovery. An alternative and more practical approach, if DNA based individualization of the fragmentary remains is unlikely to occur, may be to collect all fragmentary remains from one grid reference area in one container/body bag under one grid reference number and to give separate numbers (unique tracking numbers) at the triage only if such parts have high identification potential.

1.4 Storage

Analysis of fragmentary human remains will not commence immediately after recovery. It will take some days, weeks or even months to initiate this process. Until such time it is important to store the remains in an appropriate manner, taking into consideration the fact that subsequent identification, if this is to be attempted, will be based on DNA profiling. Thus further degradation should be minimized as much as possible.

Ideally the fragmentary remains that are collected at the scene and those that have been identified during postmortem examination should be frozen at -20°C. However, the method to be used will always vary on the availability of resources and amenities. For bony fragments temporary burial is an alternative when refrigeration is not available.

2. Identification of fragmentary human remains

2.1 Overview

Whether or not the fragmentary remains will be subject to any identification procedure will depend on the aims of the operation. The availability of funds, personnel and the time that can be allocated for identifying the fragmentary remains need to be considered. In most circumstances resources are limited. The **fragmentation index** (ratio of recovered remains to the number of deceased) and **triage probative index** (classification of human remains according to their identification potential or investigative value) (5) are tools that can help in deciding if the fragmentary remains have any realistic possibility of being identified and the related method/s to be used. The identification will generally rely on molecular methods such as DNA profiling. As these methods require considerable resources (human, logistical and financial), the sooner the decision is made the better. In some operations, it may be necessary to proceed without actually knowing what that decision will be.

2.2 Triaging for identification

a. Sorting human from nonhuman remains

The remains collected from the scene can consist of human and non-human remains (animal remains and rubble), other evidence and personal effects. The focus at this stage, if at all possible, is to separate the human remains from non-human remains. Ideally this work should be undertaken by a forensic pathologist and/or anthropologists, depending upon the nature of the fragmentary remains, as these decisions are final and irreversible. Depending on the scale of the disaster and the resources available, morphology studies, microscopic studies using dissecting microscopes and SEM/EDS studies may be useful.

b. Triaging

Triaging is carried out after the fragmentary human remains have been separated from the non-human remains. Usually the triaging of body parts is led by anthropologists at the mortuary and the subsequent examination would be carried out by a team of forensic experts consisting of forensic pathologists, forensic odontologists, finger print experts and DNA specialists.

Radiography (of fragmentary remains with skeletal elements) and photography of all the body parts are the initial steps in the triaging process. Following this, the material should be subjected to a morphological study by an anthropologist or forensic pathologist. This may identify skin fragments with

friction ridges potentially amenable to identification, or teeth for example. Once the initial morphological examination and documentation is completed then the remains should be separated into two groups as:

1. Fragmentary remains with potential for identification
2. Fragmentary remains with little or no potential for identification.

Factors that will contribute to a conclusion that remains have little or no potential for identification will include: the degree of fragmentation, the amount of heat damage and/or the degree of decomposition. The basic principle that is used in categorizing remains as having little or no potential for identification is that: ***the remains are lacking potential identifiable characteristics under the highest scientific standards and as the likelihood of identification is low, there is insufficient justification to proceed to any further examination.*** An example of this might be what appears to be a charred remnant of adipose tissue, perhaps 2-3 millimeters, or even centimeters, in size.

2.3 Documentation

Potentially identifiable remains must be numbered and documented before being subjected to further analysis, including any sampling process. A unique tracking number should be assigned to each remain which has a potential for identification. The tracking number should make it possible to track back to the site of collection.

2.4 Identification

If fragmentary remains are not to be further identified, then they will be collected together for disposal. Such remains could be designated as “group remains”. If they are to be identified (as for example in 9/11) they must be individually numbered and documented. If they are to be identified, the methods of identification applied to fragmentary remains depend mainly on the degree of fragmentation.

When considering DNA profiling, the size of the fragment is an important consideration i.e. after sampling will any tissue be available for re-union. It is also important to carry out the morphological analysis before obtaining samples for DNA analysis. However, if the ultimate goal is to identify **all** the remains then all fragments should be subject to molecular analysis no matter how small the recovered remain. Disaster-induced commingling (Type 2 commingling (4) - remains of one individual being embedded with another during the disaster) needs to be considered before samples are obtained for DNA analysis. Type 2 commingling is common in high impact disasters where bone fragments from one individual may become embedded in the soft tissue of another individual.

Once the remains have been identified they should be subject to the same procedure that applies to the release and notification of bodies and body parts in the particular incident. If the identified human remains are from a person who has already been identified, then the remains should be treated according to previously obtained family wishes.

If the identification of the human remains leads to a new identification, then the information should be passed to the leader of the “Dead Body Identification” team. Ideally it should then be presented to the Identification Board/Coroner for formal identification and the issuing of a death certificate as appropriate.

3. Final release of fragmentary human remains

3.1 Re-association and return to families

Identification of fragmentary human remains may take a considerable period of time. The results of DNA analysis will often not be available within a short period of time. Therefore, by the time the fragments have been identified, the individual concerned, in greater or lesser part, may already have been returned to the family. It is therefore important to be aware of the possibility of later identification of fragments of already identified individuals. This should be discussed with the family, and their wishes regarding the handling of fragments later identified as originating from their family member should be documented. If the identification of the fragmentary remains occurs after the release of the main parts of the body to the family, the documented family directions should be followed.

If the wishes have not been recorded, then the Dead Body Identification team leader(s) must decide how to inform the family of the identification of the fragmentary remains. The family should be advised as soon as possible. In this discussion with the family, it could be suggested that it might be best to wait until the completion of the investigation of fragmented remains so that the family is not subject to distress each time a body part is identified. This gives the family some time to decide what they would like to do with the fragmentary remains.

3.2 Disposal

At the end of the operation final disposal must be arranged for the unidentified fragmentary remains and for the “grouped remains”. (Note: Separate arrangements may be required for fragmentary remains which have been identified but have not been claimed by relatives). This should be meticulously planned

as the process is generally irreversible. All measures should be taken to ensure that “evidence” or UPE recovered during this process have been separated from the remains.

Final disposal should be undertaken according to the relevant local customs, religious traditions, and cultural values and also taking into account medico-legal issues that may later arise. This should be planned by a team consisting of forensic pathologists, coroner/magistrate, local authority administrators, religious representatives, family liaison officers and most importantly of all, representatives of the affected families and/or communities. Identified but unclaimed fragmentary remains or body parts should ideally be buried in a designated place and recorded so that it is possible to later direct relatives to the site should they wish to visit it. Whether the remains should be buried together or separately is an issue that needs to be addressed by the team mentioned above.

In relation to unidentified fragmentary remains (grouped remains and fragmentary remains which were subjected to identification process but not positively identified), it may be advisable to bury all the remains from a given grid/area together, and record this accurately so it can be traced. Remains that have been recovered from a particular grid/site should be placed in one body bag and tagged with the grid number. The ideal place of burial will be the place where other unidentified bodies have been buried, but separate from them. It should be possible to later locate the grave site for these unidentified fragmentary remains.

References

1. Interpol. Disaster Victim Identification Guide. (2014)
2. PAHO, WHO, ICRC, IFRCRC. Management of Dead Bodies after Disasters: A Field Manual for First Responders. 2nd Edition. (2016)
3. Gill, James R., et al. "The 9/11 attacks: the medicolegal investigation of the World Trade Center fatalities." *Forensic Pathology Reviews*. Humana Press, 2011. 181-195.
4. Mundorff, Amy Z. "Integrating forensic anthropology into disaster victim identification." *Forensic science, medicine, and pathology* 8.2 (2012): 131-139.
5. Kontanis, Elias J., and Paul S. Sledzik. "Resolving commingling issues during the medicolegal investigation of mass fatality incidents." *Recovery, analysis, and identification of commingled human remains*. Humana Press, 2008. 317-336.