Xournals

Academic Journal of Anthropological Studies

ISSN: 2581-4966 | Volume 04 | Issue 02 | October-2021

Dentistry In Course Of Disaster Victim Identification

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Available online at: www.xournals.com

Received 21st August 2021 | Revised 21st September 2021 | Accepted 25th September 2021

Abstract:

Disaster Victim Identification (DVI) is mainly based on the comparison of Ante Mortem data of the missing persons and Post Mortem data of the victims. Odontology, being one of the primary identification methods, plays a very important role in victim identification on the condition that dental ante mortem data are available and accessible. Forensic odontology is involved in all five phases—Scene, Post- mortem, Antemortem, Reconciliation and Debrief. Planning, adequate funding, international cooperation and standardization are essential to guarantee an effective response. A Standard Operation Procedure should be utilized to maximize quality, facilitate occupation and health issues, maintain security and form a structure to the relief program.

Keywords: *Forensic odontology, Disaster victim identification, Disaster management Checklist*

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Introduction

Over the years forensic odontology has been a major contributor to the identification of victims in disasters. Today forensic odontology is considered to be a specialized and reliable method of identification of the deceased, particularly in multiple fatality incidents. Forensic odontology is one of three primary identifiers designated by Interpol to identify victims of mass casualty events **(Berketa *et al.*, 149; Moody, 65; Lain *et al.*, 363; James, 6; Cordner *et al.*, 2011; www.interpol.int)**. As dental structures are the most durable of human tissue **(Whittaker, 146)**, the utilization of odontology continues to provide evidence of identification of victims subjected to the extremes of heat, trauma or decomposition **(Avon, 454; De Valck, 16)**. Even when victims are not severely compromised, forensic odontology proves to be rapid and cost-effective relative to DNA analysis. The Interpol DVI Standing Committee recommends that planning, adequate funding, international cooperation and standardization is essential to guarantee an effective response (Figure No. 1 to 3) and Figure No. 4 is the Modified Interpol post-mortem odontogram. **(De Valck, 17).**

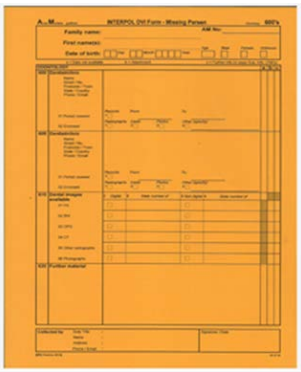

Figure No. 1: First Page of the Yellow Ante-mortem Form

Figure No. 2: Second Page of the Yellow Ante-mortem Form

Figure No. 3: Third page of the Yellow Ante-mortem Form

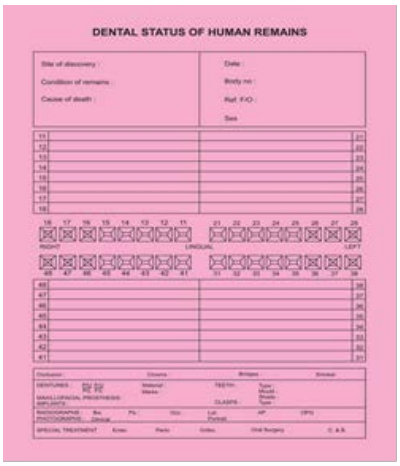

Figure No. 4: Modified Interpol Post-mortem Odontogram (Post-mortem Form)

However, every multiple fatality incident response has its idiosyncrasies that will require both flexibility and planning **(James, 275)**. Dental teams are utilized in collecting and systematically recording both antemortem (AM) and post-mortem (PM) data, as well as comparing the data and reporting the evidence. They are therefore involved in all five phases—Scene, Post-mortem, Antemortem, Reconciliation and Debrief. To maintain quality control, each phase should have a dental team leader who manages the daily activities of the phase and reports to the odontology coordinator. The odontology coordinator oversees all odontology aspects and reports to the Disaster Victim Identification (DVI) Commander. The less experienced odontologist must be paired with an experienced odontologist to limit error. To minimize bias no odontologist should peer-review their data nor be involved in reconciliation if they have had input at

an earlier stage. This review aims at a better understanding of the role of Forensic odontologists in disaster Victim Identification.

Methods of Identification

The primary and most reliable methods of identification are comparative dental analysis fingerprint analysis and DNA analysis. Secondary methods of identification include personal description, medical findings as well as evidence and clothing found on the body. These means of identification serve to support identification by other (secondary) means but do not provide sufficient scientific evidence and are thus not sufficient as a sole base of identification. All possible methods - primary and secondary-should be used as part of the whole identification process to lead to the identification of the presumed victims. The odontological identification of unknown subjects is mainly based on the comparison of dental AM (ante mortem) and PM (post mortem) elements. This was a common technique already used in several historical cases. The origin of the AM information in some of these cases came from several sources of documentary evidence. Oral testimony from family, treating dentist(s) and/or dental technician(s), written evidence and/ or drawings from dental records, X rays, dental casts, close up photos were used to establish a dental AM record from the alleged victim **(James, 277; Byard, 2; Rutty *et al.*, 5)**. As dental practice and practice management have changed tremendously in the past decades the kind and source of dental AM information obtained from treating dentists in present times has different origins and could/ should be considered to be more correct and complete and thus more valid than in those earlier days. Dental administration software programs do or should produce a more accurate AM record than the handwritten notes from the past but are still sensitive to human errors. The fact that a lot of countries do not have stringent legislation on dental record keeping though may leave the forensic odontologist in identification cases with an enormous problem. Even in countries with strict legislation on the content and the time a dental record has to be kept we still face the fact that not all patient dental records do match these legal requirements **(Byard *et al.*, 60; Sweet, 19; Winskog, 2012; Hill, 2011)**. This may of course create problems when attempting to create a consistent, correct, and valid AM dental record. Moreover, it will compromise the outcome of our efforts to establish the identity of the unknown victim(s). In addition to the AM - PM comparison to establish identity, odontologists are also able to provide additional information about certain aspects of a person's life or lifestyle by examining the teeth. These can be valuable when searching ante mortem databases for potential matches. Age estimation by evaluating the dental developmental stages is very useful in establishing the chronological age at the time of death **(Wood, 30; Andersen, 23; www.winid.com, 2004; Silver, 2009; Bassed, 2011)**. It might be possible based on the type of dental treatment or materials used to estimate the country or region of origin for a given victim. These can then be used to limit or restrict the population to search for possible ante mortem data.

The 5 Phases of DVI

Scene: At the scene of a disaster, the deceased victims and body parts are located, documented and imaged before retrieval, together with evidence collected which might assist in the identification of those victims. The scene retrieval teams are usually police officers trained in specific DVI protocols **(Lain *et al.*, 364)**. In environments of severe incineration or trauma, it is wise that odontologists attend with the retrieval teams to maximize, document and protect the evidence. Before entering the disaster area, odontologists must be equipped with appropriate safety equipment (helmets, overalls, boots, rubber gloves, etc.) and follow guidelines set out by the local scene commander **(Berketa *et al.*, 151)**. Dental remains subjected to incineration are often reduced to friable or fragile components. Protecting fragile remains at the scene and during transportation to the mortuary is critical as destruction will result in difficulty obtaining post-mortem evidence and lead to problems during the reconciliation (formal identification) phase of the investigation **(Hill, 2011)**. A high-resolution portrait image of the head and surrounding area taken before the body is moved may also prove extremely useful for comparative analysis with antemortem photographs and dental data, as well as assisting in the assessment of the material that has been lost in the transfer. A camera equipped with virtual point GPS tracking may be advantageous. Odontologists would also be able to expertly identify dental structures such as implants, dental appliances, restorations and individual tooth parts that might have been dislodged from the deceased. Ensuring that all dental evidence is recorded, collected and protected should reduce the number of revisits to the scene **(James, 282; Hill, 2011)**.

Post-mortem: The aim of the post-mortem phase is the collection of objectives, maximized, retrievable and quality controlled dental data and images for utilization in the reconciliation phase **(Berketa *et al.*, 153)**. The post-mortem examination should be undertaken at a secure mortuary site and the remains examined by two forensic dentists to document and confirm the findings. Photographs and full mouth

radiographs are usually taken **(Wood, 29)**. A designated area for odontology examinations should be allocated. If computer technology is to be used a clean area is required for data entry and uploading images. Post- mortem data can be directly entered into available computer software such as DVI System International (Plassdata, Holbaek, Denmark) **(Berketa et al., 2012; Andersen, 24)** or similar software such as WinIDTM **(www.winid.com, 2006)** or NCIC **(Silver, 2009)**. This may save considerable time, duplication of effort and reduce the risk of transposition error, but must be balanced against the potential conflict of use, and decreased efficiency of using a search engine **(Bassed, 2011)**. The terminology and glossary of terms should be strictly adhered to from the SOP to minimize misinterpretation and error. All imaging, including dental radiography, should ideally be in digital format so specific protocols regarding the chain of evidence and data storage requirements are met **(Wood, 31)**. Digital radiographs would exclude the errors that could occur in chemical developing, fixing, improper mounting and scanning. Portable, hand-held, lightweight, battery-powered X-ray machines such as the Nomad (Aribex, East Orem, USA) is useful in the mortuary for dental radiographs **(James, 283)**. This avoids a large number of operational problems associated with a mains type of irradiating device, which is heavy and awkward in a wet and dirty environment. Proper radiation hygiene standards, however, must be documented in the SOP and followed in practice. The examination equipment should include dental mirrors, probes, and cheek retractors for dentition photography, toothbrushes and alcohol for debris removal, spreaders, and tweezers. All examination instruments must be sterilized after use or safely discarded to minimize the potential for DNA cross-contamination. Handles of operating lights should be barrier covered and the lights themselves ceiling suspended to avoid contamination and clutter. Odontologists examining the deceased should be aware that sensitivity is needed for different national, cultural and ethical issues, with any dissection being performed only when necessary, using predetermined SOPs. Any dental structures that are removed must be labelled, photographed and returned to the body immediately **(Hinchcliffe, 72)**. Following the visual, photographic and radiographic examinations all data from the deceased should be collated, including integration of information documented during the scene phase, and reviewed with an age estimation recorded if possible. The examination should be signed and a running sheet (journal) entry added. Dental revisits at the post-mortem phase should be only to match putative antemortem radiographic or photographic angulations or to harvest a DNA sample by tooth extraction. All other data should be recorded at the first examination. Standards of procedure for staff rosters, and adherence to them by post-mortem teams, is essential as mental and physical stress can jeopardize the quality of data obtained.

Antemortem: The aim of the antemortem phase is the maximization of retrievable and quality-controlled objective dental data, including images, of a suspected disaster victim, and collation of that data in a standardized format for use in the reconciliation phase. The collection of dental data is undertaken by the police via investigators and counsellors who interview surviving family members. Data on physical appearance and property is collated, together with photographs, DNA and fingerprint samples, and information regarding each missing person's dentists and dental appliances **(Hinchcliffe, 73)**. It has been reported that police teams are not always aware of where dental and medical records could be located and what other data may assist in collating dental evidence [Sliver]. As well as the written original dental records, any existing radiographs, referrals, accounts, stone models and photographs need to be collected from the dentist. The name of the dental health insurer of the missing person and their insurance number is important, as are items from their home including mouthguards, toothbrushes, dentures, nightguards, splints and orthodontic appliances. These items can be an excellent source of DNA and recent photographs could be utilized in superimposition or facial comparison. Information in the primary dental records from the general dental practitioner can lead to further information from dental specialists and medical or allied health practitioners. As antemortem dental data may come from several different sources this data should not be indiscriminately thrown together, since the information from a particular origin may need to be validated **(James, 284)**. The antemortem dental team members must liaise with the police investigators to maximize the data collection. Odontologists working in pairs should carefully document all antemortem dental information, taking particular care concerning the dates the information was charted. The dental teams interpret and transcribe the records onto a yellow Interpol form, using FDI notation, if utilizing the DVI System International **(Berketa et al., 2012; Andersen, 23; www.winid.com, 2006; Silver, 2009; Bassed, 2011; Hinchcliffe, 73)** or the Universal notation if using the WINID software **(www.winid.com, 2004)**. Standardization of data transcription is essential for consistency. Unfortunately, many dentists' records are of poor quality due to poor handwriting, abbreviations and nomenclature discrepancies **(Avon, 456)**. Contacting the original dentist to clarify the details is sometimes helpful. As there are various charting systems around the world it is important to be familiar with these

systems as antemortem data may be provided from countries with different nomenclatures. As accuracy is paramount, discrepancies should be discussed and if there is doubt the matter should be referred to the antemortem team leader for adjudication. Care must be taken in the interpretation of radiographs. Antemortem intraoral radiographs may be either incorrectly mounted (e.g., one or more films mounted back-to-front) or mislabelled (e.g., label mounted on the back of film) **(Wood, 30)**. Digitized images may have been photographed or scanned incorrectly, leading to reversed image data **(Salo *et al.*, 20)**. When all the data is transcribed quality control protocols need to be in place for an independent assessor to check that all data input processes have been completed. As previously mentioned with post-mortem rostering, protocols are required to maintain minimal physical and mental stress to avoid jeopardizing the quality of data obtained.

Reconciliation: The aim of odontologists in the reconciliation phase is to compare post-mortem findings with antemortem information objectively, form a report on likely matches, and present these findings to a Reconciliation Board. The software DVI System International is particularly useful as a tool to compare a large number of records across several DVI specialist data boundaries. However, a final decision on any dental comparison should be made by a team of at least two odontologists rather than a computer. During a dental comparison, minor discrepancies are commonly found between the antemortem and post-mortem findings and these discrepancies need to be explainable **(Hinchcliffe, 2011)**. Objective evidence of a match occurs most often using radiographic comparison or anatomical concordance between post-mortem and antemortem dental casts. Radiographs may allow various restorative and anatomical concordant points to be identified. The number of concordant points is not as important as the quality of those features, which can be highly individualistic. If available restorative dental data are limited either due to lack of treatment or lack of recorded information, the use of photo comparison can assist the Reconciliation Board by adding some weight to the other evidence. However, identification based solely on photographs is notoriously unreliable and should be avoided **(www.interpol.int)**. Superimposition of dental structures using computer software such as Adobe Photoshop has been used to assist identification or as a filter by exclusion **(Al-Amad, 49)** but validation studies are still lacking in this area. Similarly, age estimation may assist in reducing the list of possible matches to acceptable manageable groups. Radiographs of bony shapes and sinuses may also contribute to the comparison. Dental implants, although mass-produced, may hint at where the victim lived if no antemortem information is available, especially if a batch number **(Berketa *et al.*, 3; Berketa *et al.*, 69; Berketa *et al.*, 53)** is present. A positive comparison report presented to a Reconciliation Board needs a format that is clear, unbiased, standardized and impartial and should present, including any limitations, the evidence for the conclusions reached. It must be in commonly used lay terms, without technical jargon. The use of a standardized PowerPoint (Microsoft) template presentation can be a useful means of achieving this outcome. Once presented the data and reports require suitably indexed archiving in a secure, safe, retrievable storage centre.

Debrief: The aim of the debrief stage is to review all aspects of the DVI so that lessons may be learnt to improve protocols for future events. Reports from all phases of the odontology section should be presented by the various team leaders to the odontology coordinator. This should include matters relating to staff rosters, Occupational Health Safety and Welfare matters, case flow management, security, reporting practices, areas of concern to individuals, quality assurance and quality control aspects, referencing methodology and future training needs. Each stage of the disaster, from initial notification to debrief, is analysed and a comprehensive checklist of actions is suggested. A freeware module management program, DVI Records Register, covers many aspects of DVI quality management and is freely available if requested **(Byard, 1135)**. In any mass fatality incident involving large numbers of individuals, there will be tremendous challenges faced by the forensic odontologist. Mental and physical stress may lead to errors being made. In the past, a large amount of time has been spent in examining and sampling bodies and parts that may have been examined multiple times—a very time-consuming and costly process. It has been suggested by Byard and Winskog that a way to highlight the effectiveness of a DVI exercise would be to focus on the number of cases/specimens that had to be re-examined to correct failures in procedures. Effectively enforced Standard Operating Procedures, planning, adequate funding, international cooperation, and standardization, are essential to guarantee an effective response to any DVI incident. It is not only of crucial importance that rules as written out in the Interpol DVI Guidelines are followed and applied by all DVI team members, but also that all specialists involved in DVI are suitably trained and qualified and will be deployed in appropriate roles. Different levels of experience with Interpol DVI guidelines, documents and standards, made clear the need for standardization. Internationally agreed-upon common minimum standards of training for the personnel of the different specialist sections would be beneficial to the

international community. This of course requires specialists accredited to provide these training programs and also the creation of a framework for quality control within each speciality in the overall DVI process. Flowcharts of the forensic odontology component of disaster victim identification are given in Figures No. 5 and Figure No. 6.

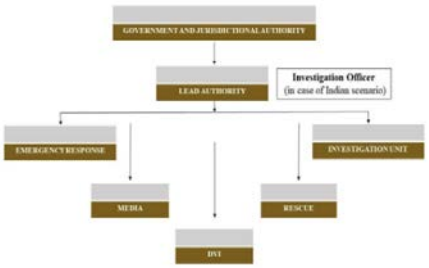

Figure No. 5: Disaster Response Management Structure Flowchart

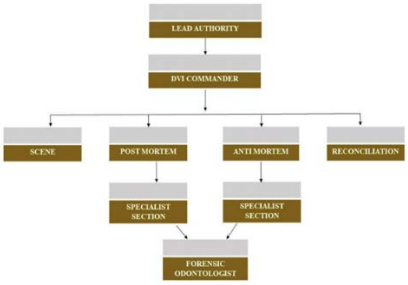

Figure No. 6: DVI structure and position of Forensic Odontologist Flowchart

Conclusion

Odontology as one of the primary identification methods in DVI has been proven to be a quick, cheap, scientific and reliable means of identification. Experiences from previous disasters have shown that the collection of dental AM data is the most challenging part of the victim identification process and that good management of the full AM data process has to be done according to existing protocols and processes to lead to a positive identification. The forensic odontologist (s) have a crucial position in the different sections of the AM team and it is of utmost importance they are familiar with the whole AM data management process which is written down in the Interpol DVI comprehensive guide.

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