



جامعة نايف العربية للعلوم الأمنية
Naif Arab University for Security Sciences

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Arab Journal of Forensic Sciences & Forensic Medicine

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الجمعية العربية للعلوم الجنائية والطب الشرعي
Arab Society for Forensic Sciences and Forensic Medicine

Primary Identification Methods and their Effectiveness in Mass Disaster Situations: A Literature Review

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Open Access

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Received 18 Jan. 2017; Accepted 16 May 2017; Available Online 05 Jun. 2017



Review Article

Abstract

Mass disasters generally result in an elevated number of casualties that need identification. The primary identification methods listed by INTERPOL (DNA, fingerprint and forensic dentistry) have a very important role in helping and speeding up the victim identification process. The present study sought to report mass destruction cases found in the literature published from 2005 to 2015 that have used the primary human identification methods. This study has been done as a literature review using the keywords: disasters, natural disasters, disaster victims, and human identification in a total of 16 selected papers and 13 listed disasters. It has been concluded that the

primary identification methods are capable and efficient to perform a safe and satisfactory identification of mass disasters victims, used both separately or in combination.

طرق الاستعراف (تعيين الهوية) الأولية وكفاءتها في حالات الكوارث الجماعية: (مراجعة علمية) المستخلص

عادة ما ينتج عن الكوارث الجماعية وجود أعداد كبيرة من الضحايا الذين لا بد من التحقق من هويتهم، وفي هذا الصدد، فإن الطرق الأساسية التي تم تحديدها من قبل الشرطة الدولية (الإنتربول) هي (البصمة الوراثية، وبصمة الأصابع، وبصمة الأسنان (طب الأسنان الشرعي))؛ تلك الطرق لها دور بالغ الأهمية كمساعد ومسرّع لعملية تحديد هوية الضحايا.

من أجل ذلك، سعت الدراسة الحالية إلى تقديم تقرير عن حالات الدمار الشامل الموجودة في المجالات والدراسات المنشورة خلال الفترة من 2005 إلى 2015. والتي استخدمت فيها الطرق الأولية للتحقق من هوية الضحايا.

أجريت هذه الدراسة كمراجعة علمية لما سبق نشره في هذا السياق، باستخدام الكلمات المفتاحية التالية: الكوارث، الكوارث الطبيعية، ضحايا الكوارث. كما تم تحديد الهوية البشرية في 16 منشور علمي و13 كارثة مدرجة.

Keywords: Forensic Science, Forensic Anthropology, Mass Disaster, Victim Identification.

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doi: 10.26735/16586794.2017.025



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خَلَصت هذه الدراسة إلى أن هذه الطرق الأولية في تحديد الهوية أثبتت قدرتها وفعاليتها في تحديد دقيق ومقبول لهوية ضحايا الكوارث الجماعية، سواء تم تطبيق هذه الطرق مفردة أو مجتمعة.

الكلمات المفتاحية: علوم الأدلة الجنائية، علم الأنثروبولوجيا الشرعي، ضحايا الكوارث، فريق الكوارث، تحديد خصائص الكوارث.

1. Introduction

The World Health Organization (WHO) defines a disaster as a “sudden ecological phenomenon of sufficient magnitude enough to require external assistance”. This definition is more adequate to describe the inability to provide adequate assistance to all people in need than the absolute number of victims [1]. Each disaster, either natural or man made, presents a different set of circumstances resulting in new challenges for the identification teams [2].

Mass disasters are the worst events and the least predictable ones [3]. Human identification is one of the most challenging problems [4] when bodies are mutilated or even fragmented. This increases the degree of difficulty and requires several specialists to correctly identify victims.

The objective of this study was to report cases of mass disasters found in literature that have used the primary methods of human identification (DNA, forensic dentistry and fingerprints) in order to check the effectiveness of each method and establish a criterion for their choice and applicability.

2. Materials and Methods

This research was carried out as a literature review approaching the primary methods of human identification in mass destruction events. The keywords used, according to

DeCs (Descriptors in Health Sciences), were: disasters, disaster victims, natural disasters and human identification found in databases such as PubMed, SciELO, and Google Scholar.

All documents in the published literatures containing case reports, literature reviews, research papers or monographs that made reference to the use of the primary identification methods in mass disasters written in English, Spanish or Portuguese from 2005 to 2015 were reviewed.

The exclusion criteria adopted were related to texts written in languages other than English, Portuguese or Spanish, texts that did not approach the primary identification methods in mass disasters, and texts that were out of the time period proposed for this work.

3. Results

Based on the searched database, 31 articles were found. After a detailed analysis of each one, considering inclusion and exclusion criteria, 16 articles were selected describing 13 different disasters; one event (Indonesia Tsunami) had four papers. All the 16 selected articles referred to mass disasters and the primary identification methods. Among the articles not considered in the sampling, 6 were not available as a complete text, 1 did not have enough data for analysis, and 8 did not have any direct relation to the primary identification methods.

Information about the mass disasters are shown in Table-1 and are composed of: year of occurrence, total number of victims (not in the case of the papers related to the Indonesia Tsunami, since there is disagreement among the authors related to the exact number; therefore, we present



Table 1- Mass disaster types and methods of identification used in each case.

Mass Disaster (Country) [Ref.]	Year	Victims	Identified	DNA (%)	Forensic Dentistry (%)	Fingerprint (%)	Combination (%)
Terrorist attack (Spain) [5]	2004	191	191	31 (16%)	-----	145 (76%)	15 (8%)
Tsunami (Indonesia) [6]	2004	1474	1474	40 (2.7%)	1175 (80%)	150 (10%)	109 (7.3%)
Tsunami (Indonesia) [7]	2004	2010	1994	26 (1.3%)	1226 (61.5%)	381 (19.1%)	361 (18.1%)
Tsunami (Indonesia) [8]	2004	2679	2148	27 (1.3%)	1105 (51.4%)	670 (31.2%)	346 (16.1%)
Tsunami (Indonesia) [9]	2004	792	111	35 (31.5%)	-----	66 (59.5%)	10 (9%)
Hurricane (USA) [10]	2005	1464	1441	72 (5%)	115 (8%)	130 (9%)	1124 (78%)
Aircraft crash (Nigeria) [11]	2005	106	97	-----	-----	-----	97 (100%)
Aircraft crash (USA) [12]	2006	50	47	-----	47 (100%)	-----	-----
Explosion (Slovakia) [13]	2007	8	8	8 (100%)	-----	-----	-----
Aircraft crash (Spain) [14]	2008	153	153	75 (49%)	7 (4.6%)	64 (41.8%)	7 (4.6%)
Aircraft crash (USA) [15]	2009	50	50	-----	38 (76%)	-----	12 (24%)
Fire (Australia) [16]	2009	173	154	-----	154 (100%)	-----	-----
Train accident (Spain) [17]	2010	12	12	1 (8%)	-----	-----	11 (92%)
Earthquake (New Zealand) [18]	2011	188	166	7 (4.2%)	58 (35%)	76 (45.8%)	25 (15%)
Traffic Accident (Germany) [19]	2011	8	7	7 (100%)	-----	-----	-----
Aircraft crash (Nigeria) [20]	2012	152	148	-----	-----	-----	148 (100%)



only the number of victims studied), number of identified victims (%), DNA based, forensic dentistry, fingerprint, and a combination of one or more methods, respectively.

4. Discussion

All human beings have an identity, which can be verified after death using several methods [21].

Human identification methods, according to INTERPOL, used in cases of disasters must be scientifically trustworthy, robust, applicable in field situations, and able to be implemented in a reasonable amount of time. Primary methods include dactyloscopy (fingerprints), comparative dental analysis, and DNA analysis [22].

In relation to forensic dentistry, identification is based on comparison of the known characteristics of a disappeared individual (antemortem data) with characteristics of an unknown body (postmortem data). Postmortem dental remains can be compared to antemortem data, including X rays, dental records, and others to confirm identity [23].

A widely used example refers to the tsunami that happened in Asia in 2004 [7,8]. Many victims were Europeans who had received several dental treatments involving porcelain works, inlays, bridges, and dental implants. This helped the identification process [24]; the method was shown to be quick, precise, and cost effective [7].

Identification through the dental arch has always played a fundamental role in natural and unnatural disaster situations, particularly in aviation disasters [21]. Comair Flight 191 (Atlanta-USA), 2006, was a closed event, and with the availability of the passengers' list, 47% of the victims were identified successfully by the dental arches [12]. In the Col-

gan Air Flight 3407 case (New York-USA), 2009, a 76% victim identification rate was achieved [15]. In the DANA aircraft crash (Nigeria), 2012, there was a combination of forensic dentistry with DNA analysis, resulting in 100% (148) of victims being successfully identified. Forensic dentistry was the method of choice in 10% of cases [20].

Teeth not only represent an adequate reservoir for such unique characteristics but also survive better in postmortem events that can disrupt or modify other body tissues. In addition, the dental method is unique, fast, and practical, mainly when it is carried out by a forensic odontologist. It is known that dental enamel is the hardest tissue in the human body and is able to bear ante and postmortem damage. Teeth are considered excellent postmortem material for identification with enough points of agreement to get to a significant comparison [23].

In the DNA and forensic dentistry interface, dental pulp is an excellent source for DNA analysis [2]. Generally, after the subject's death, teeth are the last part of the victim to be damaged in comparison to other parts of the body. Moreover, dental registers are an invaluable asset in the case of mass disasters, criminal investigations, and in legal-medical issues [28]. A tooth is a valuable source of DNA as it preserves the genetic material from extreme environmental conditions. And when analyzed morphologically, one tooth has valuable information about the individual it belongs to [27].

Another primary identification method, DNA technology, is normally used in the identification of victims of mass disasters [25] when dental comparisons and fingerprints are not possible. DNA tests have become a conclu-



sive method in cases where fragments of the human body are found [25]. In a case that occurred in Slovakia, several non-identified explosives were detonated and eight people died. Each victim was identified using DNA analysis, due to the high number of fragments found [13]. The DNA extraction process was refined and improved to get the best DNA yield [25].

DNA analysis techniques are also used in combination with other techniques used in the identification of disaster victims, mainly when attempting to identify a severely mutilated body [2]. In a case in Barcelona, 12 victims died, and 11 (92%) were successfully identified with a combination of DNA analysis and fingerprints [17]. In another case in Port-Hatcourt, Nigeria, an air disaster occurred with 106 victims. With the help of the above method combination, 97 victims were successfully identified [11].

The classic procedures of forensic pathology and forensic dentistry are frequently enough to successfully identify victims. However, in some cases, the DNA analysis method becomes essential [29]. On April 19th 2011, a road accident in Germany resulted in the death of 8 victims. Being considered a closed disaster, successful identification was possible with the help of DNA analysis in seven victims [19].

Historically, fingerprints have been used for the purpose of human identification. However, in some cases, such as severe burns and skeletonization, they are easily destroyed. Therefore, as with other identification methods, other comparative data from the victim before and after death must be obtained. Moreover, it must also be taken into consideration that this information can be unavailable

or incomplete [30].

Fingerprints can be registered and stored for use in comparison procedures. There are two methods to obtain fingerprints: 1) Acquiring official documents containing the fingerprints of a victim such as national identification documents, police records, passports, and bank accounts, etc., 2) Taking latent fingerprints that can be found on the surface of a victim's personal belongings (electronic devices, books). In the process of victim identification in the terrorist attack that happened in Madrid (Spain), fingerprints contributed to the identification of the majority (76%) of victims [5,26].

Both in the victim identification of the terrorist attacks in Madrid [5] and the plane accident in the airport of Barajas, in 2008, most victims were rapidly identified through their fingerprints because they were compared to the civilian database. In Spain, people above 14 years of age are obligated to possess a national identification document, and during the application process they need to supply fingerprints of both indexes [14].

Fingerprinting remains the best and the most commonly employed method to establish personal identification and for identifying criminals, because of their unique property of absolute identity. Even the fingerprints of identical twins are different [31].

Therefore, based on several reports, we were able to verify that a combined identification method can increase the efficiency of identification, increase the confidence level in the moment of identification, and potentially reduce mistakes in the identification process [9].



5. Conclusion

It has been concluded, from the above literature review, that the primary identification methods have shown to be capable and effective for the accomplishment of victim identification in mass disasters being used both separately or in combination.

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