A Comparison of Victim Identification Effectiveness between Digital and Analogue Dental Antemortem Data as Humanitarian Operation

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Abstract

This study aims to compare the effectiveness of victim identification between the use of digital antemortem data with integrated information system Quick Response Code and the use of analogue antemortem data with conventional systems as humanitarian operation.

This research used mixed method embedded explanatory sequential design. The Quantitative primary data were obtained using the PIECES approach from 80 respondents with a Likert scale questionnaire and followed by qualitative primary data collection by in-depth interviews with 8 informants who were determined by purposive sampling and observation. The procedure for testing digital antemortem data with an information system design and analog data with conventional systems was carried out on 120 antemortem data. Each data consisted of 4 types, namely odontograms, panoramic photos, digital photos of faces and dental prints.

Participants had given better answers by 55,38% with a value of 3.52. The results of test antemortem data on the type of odontograms (96,6%) and rugae palatine (83,3%) data types show higher accuracy than digital photo record of faces (72,5%) and X-rays foto (71,7%). The victim identification process requires digital data form and an information system to increase its effectiveness.

The comparison between digital and analog data shows that the digital dental data antemortem type and using an information system had been successfull and more effective than analogue type using conventional system.

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Introduction

The incidence of mass disasters, increasing population, changing climatic conditions, faster public transportation avenues and increasing criminal activities, will likely increase in the future which cause many casualties[1], with the physical condition of the bodies damaged and unable to recognized visually, the state is obliged to carry out forensic identification to reveal the certainty of the identity of the victim. [2]

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Disasters can also be further divided into open disasters, closed disasters or open and closed disasters. Disasters such as earthquakes, tsunamis, and train accidents belong to the open Mass Disasters category. In these disasters, the names of the victims are usually unknown. On the other hand, air crashes, ferry disasters, and hotel fires are examples of closed disasters, where the names of the victims can usually be obtained.[3]

The urgency of carrying out identification, in addition to knowing the causative factors for prevention purposes, is also to uphold human values in order to meet administrative needs related to inheritance rights, insurance, the funeral process for the victim in accordance with religious beliefs and provide psychological comfort for the family left behind.[4,5] Humanitarian forensic action is the application of the

knowledge and skills of forensic medicine and science to humanitarian actions, especially following conflicts or disasters.[6] The principle of identification is implemented as quickly as possible, easily and prioritizes ethics[7-9]and must not be mistake n in determining the identity of the victim.[10-11] It is better not to be identified than to be mistakenly identified. Forensic identification of the victims is a very challenging task because dead bodies are often mutilated to such an extent that they cannot be identified by general physical examination alone. [12]

Interpol has compiled a forensic identification guide based on Primary Identifier which consists of fingerprint, dental records and Deoxyribose Nucleic Acid and Secondary Identifiers which consist of medical, property and photography information.[13] The identification process consists of 5 phases, namely; first responders, collecting postmortem data, presenting antemortem data, reconciliation and debriefing. [2]

The implementation of the concept of self-identity as a universal basic human right is that every country has the obligation to carry out forensic identification of incidents that cause victims to lose their lives to establish certainty about the identity of their bodies. In Indonesia, regulations governing the implementation of identification are contained in the Criminal Procedure Code [14], Law on Disaster Management [15] and Law Number 36 Year 2009 concerning Health.[16] The authority of administering forensic identification of victims of disasters involving civil society is the Indonesian Police[17] and may involve other elements, including the Indonesian Army.[18]

Experience in the field of carrying out identification using fingerprint data is prone to damage due to the decay process or burns. Until now, the use of Deoxy Nucleic Acid still requires special facilities and competencies and a relatively long time to process it in the laboratory.[19] Meanwhile, the use of dental hard tissue at forensic odontology, has many advantages because the dental material does not decompose even though it is submerged in the water and burns.[20] Speed-up disaster victim identification process is a demanding task and can be successfully completed by proper planning and executing with forensic tools and key experts.

Forensic Odontology has played a significant role in victim identification and considered to be one of the most reliable and economic scientific methods.[21] The identification operation in the Bali Bombing I case in 2002, the disclosure of identity through dental means reached 56%, in the burnt bus traffic accident in Situbondo, Indonesia it reached 60%.[22] Various methods used in FO for identification include review of dental case records, anthropological assessments, and analyzes of restorations, dentures, radiographs, bite marks and intra-oral photographs, as well as, cheiloscopy and rugoscopy. [23]

In its history, Siegel et.al (1977) introduced the use of computers for the purposes of forensic odontology by changing the character of the data into algorithms. Then in 2007, two identification systems were tested, namely Disaster and Victim Identification (DAVID) and WinID3 and the results were still not satisfactory. Because the algorithm program used is limited to medical record records, namely whether there are bridges, crowns, decayed, missing, restorations, dentures and no eruptions. However updating versions of the DAVID and the WinID3 programs were being produced. The algorithms and dental characteristics of both programs remained unchanged to the versions. [24]

The used of computers in forensic odontology can be assured with more precision than manual technique. In coming years, as the technology is advancing the digital identification of individuals or deceased will become more precise and authentic[25]. Digital forensics has revolutionized the traditional forensic investigations in terms of acquisition, analysis, and reporting of forensic evidence and its application is becoming common in the mass disasters, earthquakes, and terrorism.[26]

The main problem in the forensic identification process using dental facilities is the difficulty in obtaining antemortem data.[27-31] Another problem is the conventionale implementation of the reconciliation phase as well as other technical obstacles including a tense working atmosphere, minimal facilities and infrastructure and limited forensic experts as well as different background experiences which are also complicating factors in carrying out victim identification. [32]

Based on the background of the main problems above, the researchers are interested in researching dental antemortem data

management. The research was conducted in two stages. First, analysis of information system requirements using Pieces. Second, digitizing data and using information systems in the identification process. The research was conducted on antemortem data for Indonesian Navy soldiers consists of an odontogram, X-rays, radiographs, digital photographs of the face and dental prints.

Materials and methods

This research used mixed method embedded *explanatory sequential design.* Clearance from the Institutional Ethical committee was obtained and all Informans and respondens provided written informed consent to participate in the study.

The qualitative research used PIECES (Performance, Information Economics Control Efficiency Service)[33] analysis to analyze the needs of an integrated information system Q.R. Code on dental antemortem data management and victim identification. This analysis is needed as a scientific basis for meeting the needs of an integrated information system Q.R. Code on the management of dental antemortem digital type data in the Indonesian Navy Dental Institute R.E. Martadinata, Jakarta. In quantitative part, a questionnaire with a Likert scale was used, field observations and in-depth interviews to collect primary data. Secondary data were obtained from various books, journals, and research that had been done related to the victim identification system using dental facilities.

Quantitative primary data were obtained through a Likert scale questionnaire on 80 respondents. The inclusion criteria for respondents were Indonesian Navy Dental Institute members consisting of dentists and dental nurses who had been involved in managing antemortem data. Participants chose the answer categories; Strongly Disagree (STS = 1), Disagree (TS = 2), Netral (N = 3), Agree (S = 4), Strongly Agree (SS = 5) by giving a cross (X) on the answer that was considered suitable.

The next study stage was to collect qualitative data through in-depth interviews with 8 informants who were determined by purposive sampling and field observations at Military Dentistry Department Of Indonesian Navy Dental Institude R.E. Martadinata.

Reconciliation system testing procedures carried out on 120 samples of Indonesian Navy soldiers whose antemortem data had been compiled at Indonesian navy dental Institude R.E. Martadinata. The test group was divided into two and each consisted of 60 with 30 male and 30female.

The procedure for digitizing dental antemortem data related to the measurement results with decimal numbers, then rounding is applied. If a decimal point is below 5, it will be rounded down, but if the number after the comma is equal to or more than 5, it will be rounded up, as follows :[34]

1. The digitization of the odontogram data is carried out by writing down the examination result data including Decay, Missing, Filling-Teeth (DMF-T). The tooth was considered carious (D) if there was visible evidence of a cavity, including untreated dental caries. The missing (M) included teeth with indications for extractions or teeth extracted due to caries. The filled (F) included filled teeth. [35]

2. Panoramic X-rays were measured by CPI (Coronal Pulp Index) on 4 mandibular teeth, namely the right and left first molar and first premolar .[36]

CPI = CPH X 100/CH;
CPI = *Coronal Pulp ndex;*
CH = *Crown Height,*
CPCH = *Crown Pulp Cavity Height.*

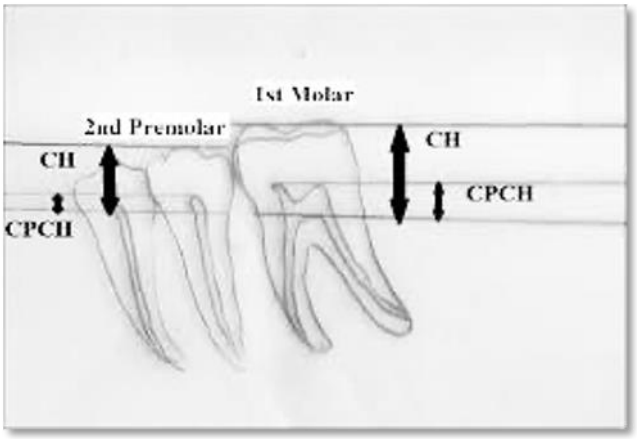

Figure 1. Measurement of the Coronal Pulp Index [37].

3. Digital photo of the front view with the body and head upright against the wall and the bite in a centric relation was taken with an automatic digital camera with a distance of 40 cm.

Furthermore, the photos were recorded in postcard size and then the vertically physiological dimensions were measured.[38]

4. Dental casting data were described through 3 data. Firstly, the measurement of the maxillary width at the distance between the mesial sides of the right and left first molar teeth. Secondly, the arch length of the maxillary teeth was calculated starting from the mesial side of the right first molar to the mesial side of the left first molar.[39] Thirdly, utilize the soft tissue of the palatine rugae using the Trobo Classification which reads from the right molar side clockwise to the left molar side.[40] This classification divides rugae into simple rugae, classified as ABCDEF, where rugae shapes are well defined, and compound rugae, classified as type X, with a polymorphisms variety. The rugae shapes that correspond to the respective classification are: A = point; B = line; C = curve; D = angle; E = sinuous; F = circle; X = compound. [41]

Figure 2. Trobo's Classification of Rugae Palatina.

Identification Method		Reconciliation Results		Total
		Positive	Negative	
Odontograms, Radigraphs, Face photographs, Dental prints	Identification with digital data and use of integrated information systems QR Code	a	b	
	Identification with analogue data and use of conventional system	c	d	
Total				

Table 1. Identification effectiveness on the use of the digital and analogue dental antemortem data.
Source: Principles of Epidemiology in Public Health Practice [42].

The reconciliation procedure for determining the identity of the victim was simulated through random sampling and a blind method of two times. The first ten were data digitization and antemortem data matching through the information system. The second ten as a control group were not subject to manual treatment and matching of their antemortem data. Furthermore, to measure its effectiveness, including specificity, sensitivity and accuracy, the 2x2 epidemiological table rule is used (table 1). Sensitivity = a / (a + b) x 100%, Specificity = d / (b + d) x 100%, Accuracy = a + d / (a + b + c + d) x 100%; a = positive identification on the QR Code integrated information system; b = negative identification in the QR Code integrated information system; c = positive identification in manual method; d = negative identification in manual method.

Results

From the results of qualitative research through questionnaire data collection, the researcher obtained the following data:

Variabel	Strongly Agree (SA)	Agree (A)	Netral (N)	Disagree (DA)	Strongly Disagree (SDA)
	5	4	3	2	1
Performance	54,5%	40,5%	3,0%	1,0%	1,0%
Information	66,0%	15,0%	15,0%	3,3%	0,7%
Economics	58,5%	32,0%	6,5%	1,5%	1,5%
Control	50,0%	42,5%	10,0%	17,0%	0,5%
Efficiency	53,3%	28,3%	10,4%	5,0%	3,0%
Services	50,0%	40,0%	7,0%	2,0%	1,0%

Table 1. Mapping of Questionary Results.

Indonesian Navy Dental Institute R.E. Martadinata, the institution in charge of identification activities within the Indonesian Navy, has collected four types of antemortem data on the teeth of Indonesian Navy members, including odontograms, facial records, panoramic radiographs and dental prints.[43] Based on the results of observations at the research location, identification activities at Indonesian Navy Dental Instiude R.E. Martadinata has been carried out since 2014. The activity carried out was the collection of dental antemortem data for members of the Indonesian Navy. There are four types of data, namely odontograms, digital facial photographs, panoramic x-rays and dental prints. The basis for the implementation of this activity is the Regulation Chief of Naval Staff Number 54 of 2011. According to Informant 1, dental antemortem data management in Indonesian Navy Dental Instiude R.E. Martadinata has used

an information system built by the Indonesian Navy's Information Service in 2014, but data input is still manual and data types are analog.

No	Year of Collection	Working Units	Total
1	2014	Jkt Lanudal, Kopaska, Brigif 2, Kilonlamil, Ambar, Foreign Service (QuarterIII and IV)	3,995
2	2015	Kormar, Koarmabar, Kopaska, lanmar Jky, Lantamal III, Yonkemar, YonmarIV, Pasmar 2, Dinal Foreign Affairs	1,600
3	2016	Pushidrosal, Pasmar 2, AAL, Department of Foreign Affairs	1,600
4	2017	Yonmarhalan III, Pasmar2, AAL, Armatim, Armabar, Foreign Service	1,600
5	2018	Armada I, AAL, Lanal Banten, Lanal Jogjakarta, Lanal Bandung, Lanal Cirebon, Dinal Foreign Affairs	1,600
6	2019	Lanal Tegal, Lanal Cilacap, Lanal Semarang, Denma Mabesal, Lantamal VII, Fasharkan MTG, Foreign Service	1,600
		Total	11,995

Table 2. The Amount of Antemortem Data for Indonesian Navy Soldiers in 2019.
(Data source from the Indonesian Naval Dental Institude R.E. Martadinata)

Variabel	Weakness of conventional	The porposed system	score
Performance	Analogue data	Digital data	3,48
Information	Take a long time	Will be faster	3,64
Economic	High cost	Low cost	3,08
Control	Difficult to control	Controling by system	3,64
Efficiency	unefficiency	efficient	3,55
Services	Long time	fast	3,19

Table 3. PIECES analysis between manual data management and use of information systems.

No.	Type of data	Sample size	Speed (menute)	Sensitivity (%)	Specificity (%)	Accuracy (%)
1	Odontogram	120	< 1	94,2	83,8	96,6
2	X-rays foto	120	> 1	76	68,6	71,7
3	Digital photo record of faces	120	> 1	73,7	71,4	72,5
4	Dental Casting (rugae palatine)	120	< 1	67,4	95,5	83,3

Table 4. The effectiveness of the reconciliation stage using an integrated information system quick respond code based on the type of data.
(The data is processed from the research findings)

Table 4 shows that the effectiveness of victim identification using an integrated information system quick respond code is very effective with the highest accuracy rate of 96.6% (p.0.05) on the odontogram. These findings are in accordance with the statement of Nagi et.al. The digital forensics has revolutionized the traditional forensic investigations in terms of collection and analysis of data. Moreover, computerized images are more reliable, accurate with fewer errors and could not be manipulated by the third person. These technologies are very helpful in disaster victim identification in which innumerable bodies are severely mutilated and allow digital transfer of the images without loss of information.[26]

Information systems require infrastructure in the form of a website[44] and data in digital format, which can be hypertext markup language to convey data descriptively in text[45] or Joint photographic experts group in picture form.[46] The system design is built to accommodate the need for automatic data storage and distribution[47] and can be integrated with a Quick Response Code (Q.R. Code) which can store data in it.[48] Q.R. Code is a type of two-dimensional barcode that has been approved as an ISO international standard and the Chinese National Standard in 2000. Q.R. The code can modify any type of data into information so that it can be accessed quickly via a computer.[49]

In Indonesia, forensic identification activities are under the authority of the Indonesian National Police[50] but in its implementation it can involve other elements, including the Indonesian Navy.[18] Regardless of the method used to identify a person, the results of the comparison of antemortem and postmortem data lead to 1 of these 4 situations; firstly, positive identification, it mean comparable

items are sufficiently distinct in the antemortem and postmortem databases, no major differences are observed. Secondly, possible identification, it mean commonalities exist among the comparable items in the antemortem and postmortem databases, but enough information is missing from either source to prevent the establishment of a positive identification. Thirdly, insufficient identification evidence, it mean insufficient supportive evidence is available for comparison and definitive identification, but the suspected identity of the decedent cannot be ruled out, then the identification is then deemed inconclusive. Forth, exclusion, it mean unexplainable discrepancies exist among comparable items in the antemortem and postmortem databases.[28]

In India, Forensic Odontology would help in identifying bodies of their soldiers and also to protect the nation from terrorists who impersonate and spread terrorism acting as a threat to the security of the nation.[27] In Japan, body identification by dentists based on dental findings preserves the dignity of the individuals and has great value in maintaining social peace and order. [51] Several countries in Europe and Asia have indeed required their dentists to complete medical records according to Interpol standards, however, the format is still analog so that it affects the speed in the data transfer process.[52] Dental identification is one of the most reliable methods, as teeth and dental structures may survive adverse conditions. The techniques involved in forensic odontology include: bite mark analysis, tooth prints, rugroscopy, cheiloscopy, dental DNA analysis, radiographs, and photographs. The digitization of antemortem dental data is a development of previous researchers. The results can be used to improve the identification process of victims by means of teeth.

Conclusions

The victim identification process requires an information system to increase its effectiveness. Transformation of dental antemortem data into digital format and the use of an integrated Q.R. Code information systems on victim identification are more effective and efficient than analogue with conventional system. The digital odontogram (96,6%) and rugae palatine (83,3%) data types show higher accuracy than digital photo record of faces (72,5%) and X-rays foto (71,7%).

Declaration of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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