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ORIGINAL ARTICLE

Human identification: a review of methods employed within an Australian coronial death investigation system

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Abstract

Whilst many identification methods have been widely described and discussed in the literature, and considered in disaster and humanitarian contexts, there has been limited reporting and evaluation of the identification methods used in domestic medico-legal death investigation contexts. The aim of this study was to evaluate the identification methods utilised at the Victorian Institute of Forensic Medicine (VIFM), which forms part of a coronial medico-legal death investigation system. The method of identification and time taken to complete the identification were reviewed for all cases admitted to the VIFM over a five-year period from 1 July 2015 to 30 June 2020. The majority, 91%, of individuals admitted to the VIFM were visually identified. The remaining 9% of cases required identification by primary methods (i.e. fingerprints, DNA or dental) or, when those methods were not possible, by secondary methods (i.e. circumstantial). Visual identifications were the timeliest, taking an average of 1.5 days, whilst primary identification methods required an average of 5 days to complete. The triaging of identification methods, dependent on the case context, body preservation, availability of ante-mortem data, legal requirements and admissibility of the method, are determined by identification coordinators within the Human Identification Service (HIS) to ensure the most appropriate and timely method is employed. This review of human identification methods provides the foundation for future analyses to compare workflow processes and improve identification methods utilised in domestic medico-legal contexts.

Keywords Human identification · Visual identification · Primary and secondary identification · Coronial death investigation

Introduction

It has long been argued that human identification, that is, the ability to assign a name to an individual, is essential for the proper functioning of society [1]. The word "identification" derives from the Latin "*idem*", meaning "the same", and is defined as "the action of making or proving to be the same" [2]. The necessity to identify a deceased individual not only fulfils obligations which may be set down in law [3], but it recognises the fundamental right of all individuals to have an identity both in life and after death, and the right of families to know the fate of missing relatives [4].

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The process of identification in medico-legal contexts involves comparing information provided by someone who knew the deceased when they were alive, typically a family member, but may also include professionals such as doctors or dentists (i.e. ante-mortem data) with information obtained by a range of forensic medical and scientific experts (including forensic pathologists, anthropologists, radiologists, odontologists, molecular biologists and fingerprint experts) during the examination of unidentified human remains (i.e. post-mortem data). There are a multitude of innate biological data and/or acquired characteristics which have been used to achieve a positive identification [5–7]. Such methods include visual identification [8]; the use of medical implants (both post-cranial [9–12] and dental [13]); dentition [14–16] (including, controversially, bitemarks [17]); anthropology [18–21]; body odour [22] and a suite of biometric data such as fingerprints [23]; palm veins and facial recognition [24]; "selfie" photographs [25]; deoxyribonucleic acid (DNA); tattoos [26, 27]; sinus and nasal septum morphology [28, 29] hand geometry; iris and retina recognition; and body shape and gait [30, 31].

Whilst the reliability of identification methods must be factored into the decision making process [32], the choice about which identification method to employ is typically context-specific and, in cases of deceased individuals, dependent on the preservation of the human remains (whether a result of peri-mortem trauma and/or post-mortem taphonomic processes) [33], the quality and quantity of ante-mortem information [34] and the availability of forensic medical experts. The advantages and limitations of many identification methods have been widely described and discussed in the literature [35–39] and considered in disaster [40] and humanitarian [41, 42] contexts. With the exception of Anderson's [43] summary of identification methods employed for the unique cases of undocumented migrants within a medico-legal context, and Covard and colleagues' [44] study of methods used to identify individuals with no initial identification hypothesis admitted to the department of forensic medicine in the west area of Paris, there has been no review and analyses of routine identifications undertaken in domestic medico-legal death investigation contexts, whether that be a coronial, medical examiner or prosecutorial system.

Understanding the process and methods of identification employed in domestic medico-legal contexts is equally as important as obtaining insight into methods used in disaster contexts, where significant discussion has been dedicated. Whilst the scale may differ between domestic medico-legal and disaster victim identification cases, the necessity for identification for legal purposes and to assist families in the grief process is the same. Subsequently, identification methods used for routine case work should be as validated and internationally accepted as identification methods used in other forensic contexts. The aim of this study was, therefore, to lay the foundation for analysing identification methods employed in domestic settings by reviewing the workflow and identification methods utilised at the Victorian Institute of Forensic Medicine (VIFM), which forms part of a coronial medico-legal death investigation system and is Australia's largest multi-disciplinary centre for forensic medical and scientific services.

Background

The role of the Coroner is to independently investigate deaths considered reportable under the Victorian Coroners Act (2008) [45] in order to establish the identity of the deceased, the cause of death and, in certain cases, the circumstances in which the death occurred. Although there is variation across jurisdictions in what constitutes a death that is reportable to a Coroner, they generally include deaths that are unnatural, suspicious, violent, unexpected, unexplained and health-care-related and where the identity of the person who has died is unknown [3, 45]. Between 15 and 25 deaths are reported to the Victorian Coroner each day [46]. Those deceased individuals are admitted to the VIFM for a forensic medical examination to assist the Coroner in determining the matters required to be addressed under the legislation. These include making a formal determination of identity if possible.

Aspects of identification-related disciplines have been in place at the VIFM since 1989 in various configurations and under several different organisational structures including a Forensic Odontology Unit (1989) and the Centre for Human Identification (2005), which included forensic odontology, forensic anthropology and forensic entomology. From the 1st August 2013, a formalised Human Identification Service (HIS), comprising forensic odontologists and forensic anthropologists as identification coordinators, was established within the Institute's Forensic Pathology Service. Depending on the circumstances, all individuals who are admitted to the VIFM are initially recorded as either "believed to be" or "unknown". The HIS is responsible for triaging the identification process for each deceased person whose death was reportable to the Coroner. The functions of the HIS involve reviewing relevant data stored in the VIFM's internal case management system (iCMS). These data include photographs of the deceased person's face and full body taken at the time the individual was admitted to the VIFM, as well as information provided in the police report of the death. Details recorded in the report include an identification hypothesis (i.e. a "believed to be" name of the deceased person based on information collected at the death scene, and date of birth if known), and whether the person had a fingerprint record and/or attended a dentist. As post-mortem computed tomography (PMCT) is a routine part of the autopsy process at the VIFM with all individuals (regardless of preservation) receiving a full body scan [47], the identification coordinator also reviews a PMCT scan of the deceased. Based on an evaluation of all this information, the identification coordinator determines whether the deceased person is suitable to be visually identified or whether an alternative identification method is required (Fig. 1).

According to the VIFM's protocol, a visual identification, where appropriate, will be the first preference for identification (see Fig. 1). A visual identification can be confirmed by a person who knew the deceased for a minimum of six months (as required by the Coroner) by viewing the deceased and signing a Statement of Identification (SoID) [48]. The details provided in the police report are required to match those provided on the SoID before the identification is confirmed. In most instances, the SoID is completed at the death scene (which may include a hospital or nursing home), witnessed by a law enforcement officer. When this is not possible, the SoID is completed at the VIFM with the assistance of trained medico-legal liaison nurses. Whilst there is a level of subjectivity involved, visual identifications are deemed appropriate when there is no/limited trauma to the facial skeleton and no or minimal decomposition changes to the face. Cases that are

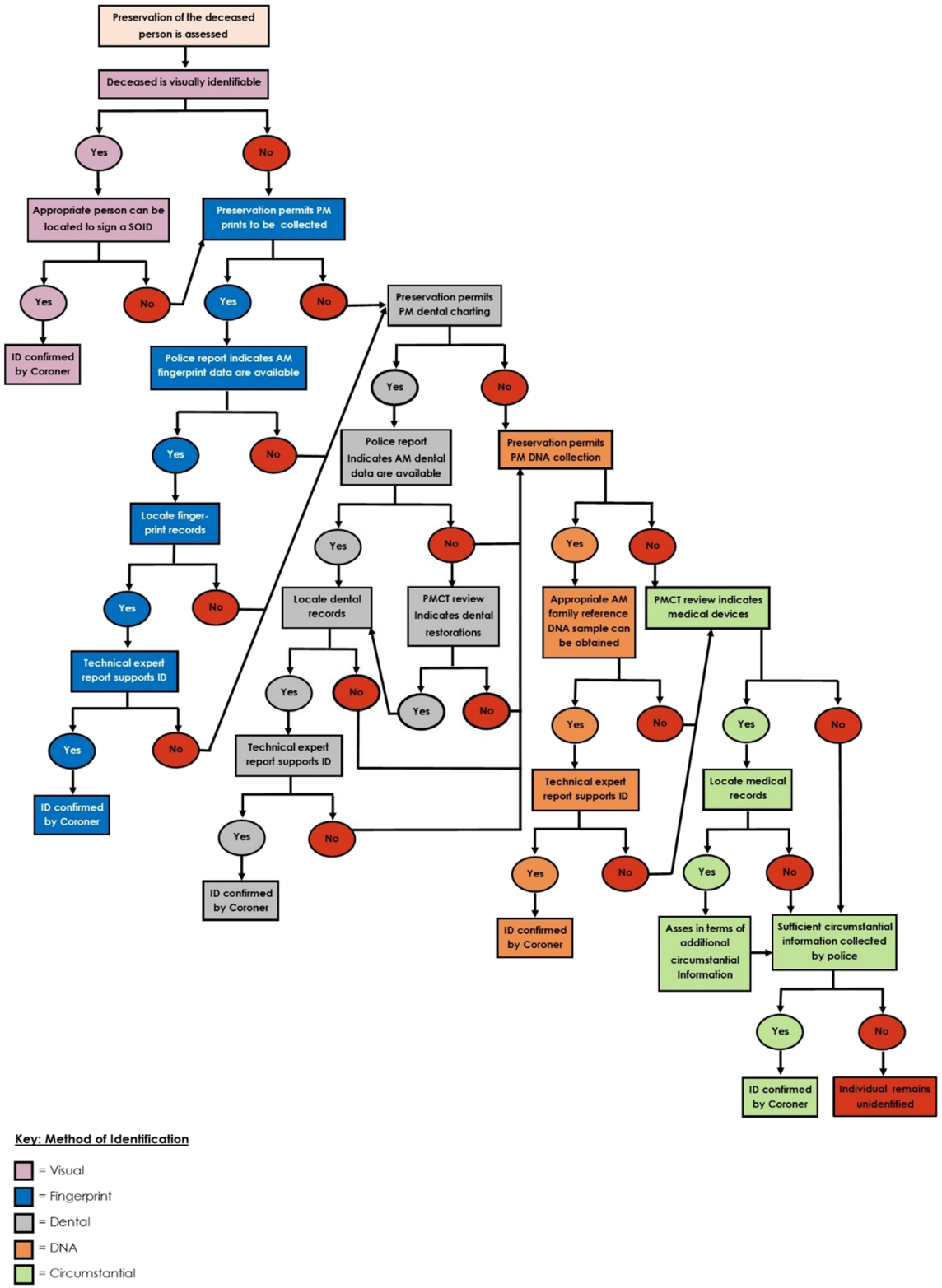

Fig. 1 Workflow of the Human Identification Services (HIS), VIFM

visually identified do not require a formal identification report.

There may, however, be situations where the person is visually identifiable, but an identification report is still required. Such situations include those where it is not possible to locate someone who knew the deceased person for more than six months to provide a SoID, or a family member does not wish to view their deceased loved one. Typically,

homicides, deaths in custody and cases involving the death of more than one individual (i.e. disaster victim identification (DVI)) also require a formal identification report even if they were still suitable for visual identification, in order to provide requisite and robust legal certainty.

Cases that are deemed unsuitable for visual identification, typically as a result of one or more variables including, but not limited to, the effects of fire, decomposition (including skeletonisation) and/or trauma, require alternative methods of identification. So-called primary methods include analysis of fingerprint, odontology or DNA data (see Fig. 1). This protocol aligns with the International Policing Agency (INTERPOL) recommendations for primary methods of positive identification [40] and is recognised as good practice in many jurisdictions [49]. At the VIFM, the forensic specialist (fingerprint expert, molecular biologist or odontologist) provides a technical report to the HIS identification coordinator, which reports the likelihood of identification according to accepted discipline standards. The identification coordinator subsequently reviews the report considering all the information about the case and, based on this review, completes an identification report. This report is then submitted to the Coroner, who is legislatively responsible for confirming the identification.

In the absence of these identification modalities, secondary methods (circumstantial identifications) comprising medical and/or circumstantial information are employed (see Fig. 1). Details of the circumstances are initially collected by the reporting police officer and may include the fact that the deceased was located at a residential address that was inhabited by the person whose identity is in question. There may also be items located at the death scene in the name of the deceased, such as medication, driver's licence and bank cards. Other circumstantial details may include descriptions of tattoos, details about medical procedures or a physical description provided by neighbours. The identification coordinator reviews this detail and, if sufficient circumstances are available, completes an identification report for the Coroner to review and confirm identity.

Material and methods

The method of identification and time taken to complete the identification were reviewed for all cases admitted to the VIFM over a five-year period from 1 July 2015 to 30 June 2020.[1] These data were acquired from the VIFM's iCMS which records a range of forensic medical information including the date the deceased person was admitted, the state of preservation of the individual, the method used to complete an identification and the date an identification was confirmed. Descriptive statistics were used to report frequencies of identification modalities employed, as well as the time taken from the date an individual was admitted to the VIFM to the date the individual was formally identified. Approval for the data review was provided by the VIFM Research Advisory Committee (1128 – 1089/1).

[1] Cases were recorded according to the Australian Financial Year.

Results

Each year between 5500 and 6500 cases were admitted to the VIFM. Except for the 2018/19 financial year, there was a steady increase in the number of cases over the five financial years. Over the five-year study period, an average of 91% of cases admitted to the VIFM were identified based on visual recognition (Fig. 2).

Cases requiring an identification report

The remaining 9% of cases required the application of DNA, odontology, fingerprint or circumstantial identification methods. For each of these cases with specialist identification testing, a formal identification report was produced. The majority of these cases, an average of 71% per financial year were poorly preserved and thus not suitable for visual identification (Fig. 3). The remaining 29% of cases were suitable for visual identification; however, due to the circumstances of the death (e.g. homicide, or where a SoID could not be completed), visual identifications were not possible (see Fig. 3).

Of the identification reports generated, an average of 85% of individuals were positively identified through the use of DNA, fingerprint or dental methods (Fig. 4). Positive identifications based on direct ante-mortem and post-mortem comparisons were made through fingerprints in 39% of cases and through dental examinations in 13% of cases. A further 31% of positive identifications were made through DNA comparisons of the post-mortem nuclear and/or mitochondrial DNA with either a direct ante-mortem sample or a sample from a family member (typically a child, parent or sibling) for a familial kinship comparison. Positive identifications were made from circumstantial information provided by law enforcement officers and physical appearance comparisons in 15% of cases (see Fig. 4). The remaining 2% of cases required the employment of more than one identification method, typically a combination of dental comparisons with supportive circumstantial information.

Timing of identifications

Over the five-year period, the average median time to finalise an identification when an identification report was not required (i.e. when the person was visually identifiable) was 1.5 days. In contrast, cases requiring a formal identification

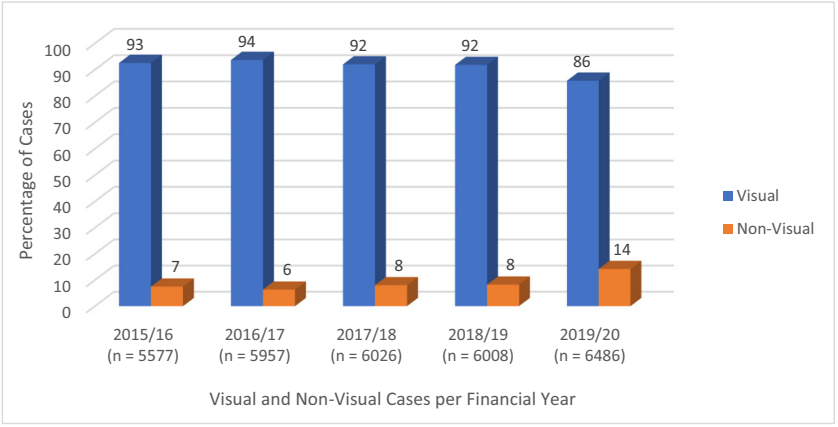

Fig. 2 Percentage of cases admitted to the VIFM over five financial years that were visually and non-visually identifiable

report, regardless of whether the person was visually identifiable or not, required an average of 5 days to complete. Fingerprint and dental identifications were the quickest methods, requiring an average of 3.5 days to complete. DNA identifications were the longest to complete with an average of 8 days. When circumstantial identifications were required, this method took an average of 7.5 days to complete (Fig. 5).

Discussion

The majority of individuals admitted to the VIFM were visually identified. Whilst visual identification is not considered scientific [50] because of the potential for errors and therefore mis-identification [3, 8, 38, 51, 52], visual identifications, particularly in domestic contexts (as opposed to following disasters) are considered acceptable [44, 49], especially in cases where the identification hypothesis is strong. At the VIFM, not surprisingly, visual identifications were completed in a more timely manner than cases requiring a specific formal identification method. The relative speed in which a visual identification is completed is due, in part, to the fact that in many cases, a SoID is completed at the death scene and accompanies the deceased when they are admitted to the VIFM. Delays in completing a visual identification may occur when the SoID is incorrectly completed (e.g. spelling errors, incorrect date of birth or the form is not signed or witnessed), or if it takes time to locate and organise for a person who knew the deceased for at least six months to attend the VIFM and complete a SoID (e.g. if the family member/friend lives overseas or inter-state).

In comparison to the total number of cases admitted to the VIFM each year, the percentage of identifications requiring an identification report, the majority of whom were not visually identifiable, was relatively low. This small percentage may be explained by the high proportion of annual cases admitted to the VIFM that are concluded to be a death due to natural cause where the potential for traumatisation and decomposition is less likely, compared to homicides, accidents and suicides. At the VIFM, the frequency with which each of the identification methods was utilised remained constant over the five-year

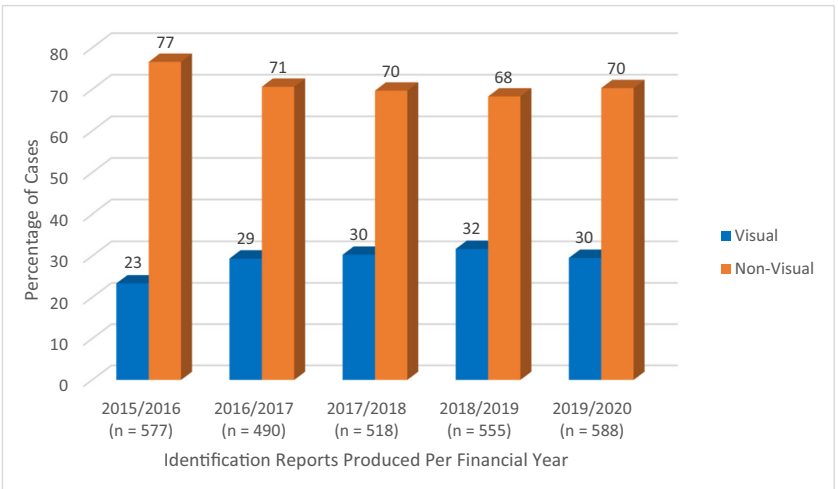

Fig. 3 Percentage of visually and non-visually identifiable cases that required an identification report

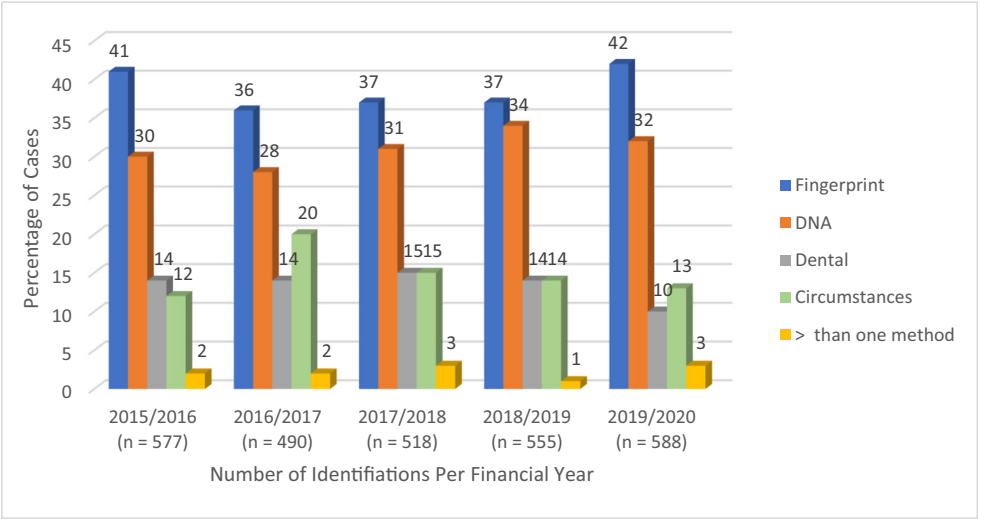

Fig. 4 Percentage of identifications according to different methods

period. This pattern may be attributed to the relative consistency in the proportion of the types of deaths admitted to the VIFM. Each year the distribution of manner of death remained constant with approximately half of all cases attributed to natural causes and the remaining half a combination of suicide, accident and homicide deaths. Context-specific differences in case types inevitably influence the methods of identification. Whilst data for the identification methods used in other domestic medico-legal death investigation contexts are currently unavailable, it would be interesting to compare such data from countries which have extremely high numbers of violent deaths such as Mexico and Colombia [51].

The duration of time some identification methods required, however, did show a trend. Whilst the length of time taken for dental and fingerprint identifications remained constant, the length of time taken for DNA and circumstantial identifications increased. Whilst the precise reasons for the time increase are unknown, it may possibly be attributable to case-specific complexities such as preservation, locating the appropriate family member for DNA analysis and organising the collection and analysis of samples, and locating and collating the appropriate information for a circumstantial identification. It appears likely that technical advancements in the digital capture and analysis of fingerprint and dental data, compared to DNA and circumstantial information, also contribute to the differences in the time required to complete identifications using the different methods.

Whilst the condition and preservation of human remains will inevitably influence the decision about which method is used, other factors also come into play, such as legal requirements about obtaining and storing fingerprint and DNA samples [53] and admissibility of the method. Although the admission of fingerprint evidence as a means of identification has been challenged as a method of positive identification in parts of the US [49], similar to Canada, this is not the case in Australia. In this study, just under 40% of cases admitted to

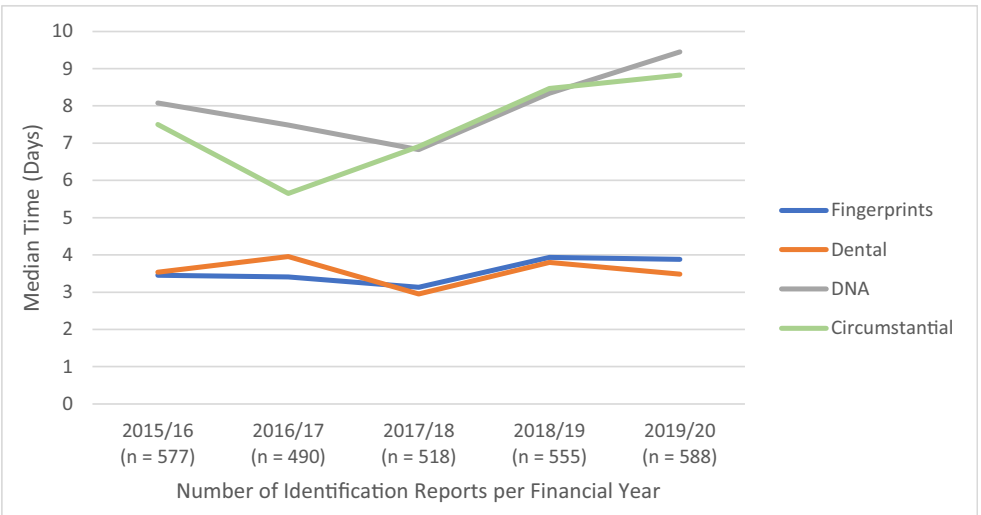

Fig. 5 The median time (days) taken to complete an identification according to the method selected

the VIFM requiring an identification report were positively identified by the Victoria Police Fingerprint Group using fingerprint records. Whilst it has been suggested that "[f]ingerprint comparison provides perhaps the most widely used scientific means of identification in the presence of soft tissues" ([50]), no data specific to identifications in domestic settings exists. The percentage of fingerprints identifications at the VIFM may be considered relatively high given that, in Australia, fingerprints are only obtained from an individual if the person is charged with a crime or if they require a police record check (e.g. when applying for a licence for specific firearms) and thus have a file on the Law Enforcement Assistance Program (LEAP) database. In Australia, police use the National Automated Fingerprint Identification System (NAFIS), which archives fingerprints for approximately 10% of the Australian population (C. Hamilton pers. comm). In addition, fingerprint data are required by law to be destroyed if a person is not charged within six months of being interviewed and having fingerprints taken, or if a person is charged and subsequently found not guilty of the offence. Thus, even if the hands (fingers and palms) of the deceased are well preserved and could be printed, there is no guarantee in Australia that comparative ante-mortem fingerprint records will exist.

Compared to a visual identification, which is completed relatively quickly, an identification requiring fingerprint data takes additional time due to the processes involved. Following obtaining consent from the case forensic pathologist for the deceased person to be printed, the HIS identification coordinator must organise for prints to be collected which, depending on the preservation may be undertaken by Victoria Police (who will attend at the VIFM for decomposed and homicide cases) or VIFM mortuary technical staff (for routine cases). Processing is then undertaken external to the VIFM with the Biometric Services of the Victoria Police Forensic Sciences Department. As outlined in Fig. 1, finalising the fingerprint report will depend on the preservation of the deceased person. An average of 75% of cases which were positively identified based on fingerprint data had details provided on the police form generated at the death scene indicating the deceased person had a fingerprint record, thus, streamlining the identification process. The fact that 17.5% of cases which were identified using fingerprint data were accompanied by police forms with missing or erroneous data may have contributed to a delay in finalising a fingerprint identification.

Although the use of dental data is an established positive identification method that has been widely used following disasters both in Australia [54] and elsewhere [55, 56], compared to fingerprints and DNA, the method is used relatively little at the VIFM. There is no doubt that access to PMCT scans of the deceased aids the forensic odontologist in establishing in a timely manner whether a dental identification is possible [57, 58]. However, similar to other countries where there are privacy issues associated with maintaining dental records (e.g. [59, 60]), dental identifications are limited by the fact that there is no systematic collection or centralised storage in the form of a database of dental records in Australia [61]. Furthermore, there is no requirement for dental practitioners to label dentures, (e.g. with the name of the patient) [62, 63] or pursue specific embedded identifying devices (e.g. [64]. On average, only 9.5% of cases which were positively identified by dental comparison were accompanied by police forms which indicated the deceased had attended a dentist. This relatively low percentage is perhaps not surprising given that only 50% of all Australians aged 15 years and over see a dental professional in a 12-month period [65]. However, the fact that an average of 46.5% of cases were accompanied by forms with no dental data and 44% of cases had either missing or erroneous dental details, more than likely contributes to the relatively limited number of requests for identifications using dental data.

DNA identifications were the second most common method of scientific identifications performed at the VIFM. Finalisation of DNA identifications, was, however, the most time-consuming. The delay may be explained by the fact that time is required to communicate with family members, establish the appropriate family tree, obtain consent and collect and process the family reference sample. In most cases, a family member provides a buccal swab sample from which DNA is extracted for comparison with DNA from a post-mortem sample. In a select number of cases, however, direct DNA comparisons are possible if a neonatal screening card (previously known as a "Guthrie card" [66]) can be located. Whilst neonatal screening cards have proved important for identification following disasters [67], in general, the number of DNA identifications based on a sample from a neonatal screening card is low. For example, in 2019, only 4 cases at VIFM were identified using ante-mortem data from a neonatal screening card (D. Hartman pers. comm.).

Another factor contributing to the delay in a DNA identification is the preservation of the deceased individual. Whilst the VIFM's Molecular Biology Laboratory is accredited by the National Association of Testing Authorities (NATA) and has the capability of conducting kinship and direct searches using both nuclear and mitochondrial DNA profiling [68], DNA identifications may also be delayed as a result of the preservation of the post-mortem samples [69, 70]. Preservation considerations have resulted in the development of novel sampling strategies at the VIFM [71] and the commissioning of a massive parallel sequencing (MPS) platform. The MPS enables advanced DNA analysis, including genotyping to predict aspects of the physical appearance and bio-geographical ancestry of a deceased person where the remains are incomplete, decomposed or skeletal.

In select cases where a fingerprint, dental or DNA identification was not possible, the validity of a circumstantial

identification was assessed. Although circumstantial identifications are considered a secondary identification method [5, 72], at the VIFM, such a method is employed when the primary identification methods are not possible to pursue. For example, the individual may be edentulous, have no fingerprint record and have no children/living siblings/surviving parents. Forming an identification based on circumstances was required in approximately 15% of cases that needed a formal identification. Circumstantial details to support the identification hypothesis are collected by the police officer who attended the death scene. Given the need to acquire and assess the supporting details, as well as work around the schedules of the reporting officers, the relatively long time to complete a circumstantial identification is expected.

Supporting disciplines for identification

Whilst not necessarily directly involved in the final positive identification of a deceased person, additional forensic specialists co-located at the VIFM may contribute to the identification process. As outlined above, all individuals, regardless of preservation admitted to the VIFM are CT scanned as part of the routine autopsy procedure. Consequently, the PMCT scans for each case are reviewed by a forensic pathologist and a forensic radiologist. Where required, the forensic radiologist will contribute details potentially pertinent for identification, such as medical implants or unique medical conditions [3, 73].

In cases where preservation initially limits the identification process, whether a single skeletal element or a complete decomposed individual, a forensic anthropologist may be requested to provide an opinion to establish if coronial identification will be required. Furthermore, in cases where there is no hypothesis of the individual's identity, as a preliminary source of data, the anthropologist may play an important role in providing details of a biological profile (i.e. age, sex, ancestry, stature) to assist law enforcement with narrowing down the pool of potential missing persons to whom the remains may belong [72]. Over the five-year period, an average of 140 cases per year have involved a forensic anthropology opinion.

In some cases where immediate identification is not possible, information about the time since death has assisted in refining the identification hypothesis. In such cases, a forensic entomologist may be requested to provide an opinion about the minimum time since death. In Victoria, an average of 10 cases per year require an opinion from the forensic entomologist (M. Archer pers. comm.).

Cases unable to be identified

In a relatively small number of cases, identification of the deceased may be significantly delayed. The delay is typically associated with the quality and quantity of ante-mortem information [34]. In the state of Victoria, there are approximately 70 cases of unidentified human remains on record dating back to 1989. In many of these cases, the preservation of the human remains when first admitted to the VIFM was skeletonisation. In all cases of long-term unidentified human remains, an anthropological and odontological (where appropriate) examination is completed and a DNA profile (ideally both nuclear and mitochondrial) generated. The DNA data are initially uploaded onto the Victorian Missing Persons DNA Database (VMPDD), an initiative developed in 2009 between the VIFM and Victoria Police following the 2009 Victorian bushfires [74]. If an identification is not achieved the case is reviewed by the Missing Persons Working Group which is made up of representatives of the key stakeholders including the head of Missing Persons (Victoria Police), VIFM forensic medical experts and the Coroners Court of Victoria. Ultimately, all relevant data are uploaded onto the National Missing Persons and Victim System (NMPVS) database, a national platform initiated in 2015 to assist with identifying long-term missing persons [53].

Future recommendations

To identify potential improvements in the efficacy of identification methods employed at the VIFM, and more broadly in domestic medico-legal contexts, comparable data with other forensic institutions are required. To date, the focus of evaluating identification methods has centred on DVI contexts (e.g. [75–77]). Consequently, there remains an international lack of comprehension of best practice identification methods for routine cases. As the majority of casework in domestic medico-legal settings involves routine cases, rather than the less common events of a DVI incident, comparative identification data would allow for the collective examination of how the methods employed, and timeliness of such methods, may be improved to advance human identification practices in the medico-legal context.

Conclusion

The process of human identification undertaken at the VIFM involves medical and scientific examinations, communication with families and liaisons with relevant law enforcement personnel and legal approvals. Consequently, a multidisciplinary and multifaceted approach for identification is required with various stakeholders internal to the VIFM (e.g. molecular biology) as well as external (e.g. Coroners Court of Victoria and Victoria Police). The HIS is the central contact point for managing these liaisons. Whilst visual recognition is the foremost method of identification at the VIFM, for cases that require a formal identification method, the inclusion of a

dedicated HIS at the VIFM ensures that the quality and quantity of the ante- and post-mortem data are scrutinised by an expert. This process ensures the timely and well-coordinated selection of the most appropriate identification method according to the circumstances of the case. With limited comparable published data from other institutes nationally or internationally, this review of human identification methods employed at the VIFM affords the foundation for future analyses to compare workflow processes and identification data relative to manner of death for routine casework within medico-legal institutions elsewhere.

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Data availability N/A.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval The research was approved by the Victorian Institute of Forensic Medicine's (VIFM) Research Advisory Committee (1128 – 1089/1).

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