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Forensic uncertainty, fragile remains, and DNA as a panacea: an ethnographic observation of the challenges in twenty-first-century Disaster Victim Identification

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This is an account of ethnographic research examining the specialist scientific processes known as 'Disaster Victim Identification' (DVI) in three settings: Québec, the United States, and the United Kingdom. In cases of multiple deaths, a series of actions accompanied by a plethora of tools are often invoked, housed at a disaster scene, forensic laboratories, a family assistance centre, and a mortuary. In this article, I examine a process dedicated to connecting the biological remains of the deceased with a confirmed validation of personhood. I describe a situation where responders/scientists will attempt multiple testing and re-testing of human remains, often pushing boundaries of available science. I argue that the search for certainty in identification lies at the heart of the activation of DVI processes, particularly when it is connected to DNA testing. Observing intimate forensic settings and the bricolage of the forensic anthropologist's labour has allowed me to track the production of the science of identity. I then reflect on the wider implications of these observations for affected communities and the responding scientists. Finally, I argue that there is complexity and ambivalence surrounding the increased use of technologies when applied to identification of victims.

When major incidents cause multiple deaths, a key priority for forensic responders, and of course for families of the missing, is to identify the deceased.[1] Depending on the incident, the bodies of the deceased can be subjected to extreme forces. The body can become dismembered, burned, and fragmented, as totemically evidenced by the scenes after the terrorist attacks across the United States on 11 September 2001 (9/11) (Mundorff 2009; Simpson & Stehr 2004; Toom 2016). In such cases, a process referred to as 'Disaster Victim Identification' (DVI) is often invoked. In incidents where the number of fatalities exceeds existing mortuary capacity and where questions surround the identities of those who have fallen victim to events, the decision to implement the DVI process is both an operational and a political one that allows access to additional resources and expertise. There has been criticism that the expensive and resource-intensive assets of DVI are more likely to be deployed to Western, socio-technical[2] disasters, leaving human loss in poorer nations under-resourced. It is also true to say that, as with all death practices, the actual activation of the processes may have many cultural and geographical specificities.[3]

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DVI operations are a continuously evolving process structured by an Interpol steering group's resolutions and detailed guidance documents (Interpol 2021; Scanlon 2007). Carrying out DVI in any one of the 194[4] Interpol member states usually involves a team of police assigned to oversee the gathering of evidence as directed by a lead investigator, working alongside forensic scientists including pathologists, forensic anthropologists, and forensic odontologists, all with the aim of identifying the dead (Interpol 2021). I have, as a responder and adviser, been involved in the practices of DVI for two decades and have been uniquely placed to observe the influence of DNA technologies on its practice.

In the United Kingdom, a Police Senior Identification Manager (SIM) is charged with gathering evidence of identity on behalf of Senior Coroners in England, Wales, and Northern Ireland and the Procurator Fiscal in Scotland. The SIM has a mandate to ensure that the deceased are recovered from the scene in a dignified manner whilst also ensuring the integrity of identification and forensic evidence, and that the deceased are identified as speedily as possible using ethical means with families kept informed throughout the process (Black, Walker, Hackman & Brooks 2010: 75). Human remains are recovered from the disaster scene to a 'holding area' while concerned families are brought to centres or in some cases asked to wait at home to be visited by law enforcement officials.[5] Along with the initial forensic work that is carried out at the scene and the mortuary, police officers deploy to gather evidence from those with a biological kinship to the suspected victim(s) such as a child or a sibling. Friends and relatives may have reported their loved ones missing through a specific phone line or online portal, been at the incident themselves, or been identified as a related person in the course of the body recovery work at the site or mortuary, where information such as next-of-kin details contained within a wallet or stored on a mobile phone may elicit such clues. Anyone tasked with family liaison responsibility will normally work with relatives and partners to complete a lengthy form, gathering detailed and personal information about the missing person.[6] This is a procedure which is often referred to by law enforcement as the 'ante-mortem harvest', one which, because of the intimate nature of the questions and the lack of information in return from questioners, has been controversial amongst families (Edkins 2008; 2019). Traditionally, this ante-mortem data, when matched to post-mortem data such as fingerprints or dental records generated at the mortuary table,[7] is then taken to some form of 'identification commission' made up of the Coroner/Procurator Fiscal, forensic specialists, and police chiefs, who formalize the confirmation of identities.

In the United Kingdom, DVI practices have been shaped by a series of public inquiries, inquests, and scandals that have followed problematic operations in UK disasters (Black *et al.* 2010; Easthope 2008; 2017*a*; Edkins 2008; Eyre & Dix 2014). Of particular importance is Lord Clarke's *Public inquiry into the identification of victims following major transport accidents* (Clarke 2001). This report followed the sinking of the *Marchioness* pleasure boat on the River Thames, which killed fifty-one people in August 1989,[8] and identified a number of improvements that were then adopted by police chiefs, coroners, and forensic personnel. The report urged a detailed review, new guidance, and a training programme for DVI responders and Her Majesty's Coroners, and many of these recommendations were enacted in the early 2000s by UK responders. However, this was not the last British DVI scandal, and mistreatment of bereaved families during the DVI process has been a frequent target of disaster advocacy groups such as Disaster Action (Eyre 2002; Eyre & Dix 2014).

Methodological approach

This article uses ethnographic data from five main areas of activity between 2013 and 2017:

1. Fieldwork in Lac-Mégantic, Québec, following a fatal fire. Visits to the town, including the places that had been the sites of the body holding area and family assistance centre. Interviews with the bereaved families, responding police and coroners, the local government recovery team, scene scientists, and public health teams. Visits to Montréal laboratories to observe/interview pathologists, DNA scientists, police, and specifically the forensic anthropologist.
2. Fieldwork in New York. Interviews and visits with the Office of Chief Medical Examiner (OCME) and scientists who responded to the terrorist attacks across the United States on 11 September 2001. Visits to the 9/11 museum and other sites in the city. These laboratories also provided a confirmatory testing facility for the Lac-Mégantic responders which was completed shortly before my arrival.
3. Ethnographic observation at a major mass fatality, Exercise Unified Response (EUR), in Kent, United Kingdom, in March 2016. This was a European Commission-funded exercise involving eight nationalities. There were over 300 fatalities in the scenario.
4. Ethnographic observation at two major mass fatality exercises, MegaDeath and Heartland, in Ohio, May 2017, involving the FBI, the National Guard, the US Military, US federal- and state-level mortuary response teams (DMORT, OMORT[9]), and Ohio mortuary and forensic response alongside private contractors. Prior to the exercises, in 2014, observation of the development of the technology had also been undertaken in Washington, D.C., at hearings of the National Institute of Science and Technology's National Commission on Forensic Science relating to issues of identification, which I also attended.[10]
5. Data workshops with a range of interested participants, including coroners, police, anthropologists, lawyers, DNA scientists, and religious leaders, designed to examine my research themes.

On 6 July 2013, an unmanned train carrying crude oil derailed and exploded into the community of Lac-Mégantic, Québec, killing forty-seven men, women, and children, destroying homes, shops, and restaurants in the town centre. Attempts to confirm identification through forensic means were quickly underway. Key roles here were played by a small and dedicated team of pathologists and forensic anthropologists working under the direction of two coroners.

I immediately realized that the Lac-Mégantic rail disaster presented a very rare research opportunity to study the latest uses of DVI technologies and practices in a situated, geographically bounded community where it was believed that most of the deceased originated from. I applied for and was awarded an urgent disaster research grant from the UK Economic and Social Research Council to allow this work to begin.

I used *autoethnography* in my research and I define my methodology as this, rather than ethnography alone, to allow me to disentangle and incorporate the role that I also play as a responder in DVI settings since this has a huge impact on aspects like access and gatekeeping.[11] In this study, I aimed to order, document, and understand the lessons to be learned from recent incidents and exercises and to make particular use of science and technology studies (STS) when developing my approach to observing disaster (Easthope 2018). When undertaking autoethnography studies, I pay close attention to

the everyday and to the tiniest parts of practice, such as the placement of a rib bone within a wider skeletal structure. This is an approach at odds with the manner in which disaster response practice is traditionally assessed and reviewed in generalized terms (Easthope 2018).

DVI as a policy and process relies on a series of shared practices and technologies. It involves the mobilization of dozens of specialists, including investigators, police, and scientists. It also involves the use of a range of documents and objects, from checklists to specialized DNA testing equipment (Black *et al.* 2010; Toom 2016). These DVI paper-based and electronic tools are, I contend, *technologies of identification* that are used to connect identities to objects and then from these objects to personhood and a *name*. Building on work in STS which expanded the definition of technologies to include artefacts and processes 'whose purpose is to produce changes in human behaviour' (Pinch, Ashmore & Mulkay 1992: 266), the processes of DVI can be ethnographically observed as they are used to produce this expertise and the identities '*scientifically*'. The final data were analysed using a set of interpretative methodologies.

Forensic uncertainty and the rapid development of DNA as a panacea

> This is my son, part of my son … I don't care if they notify me as long as I live.
> Grieving 9/11 parent as reported by Jo Craven McGinty in *The New York Times* (2011)

Identification bestows personhood to remains (Toom 2016; Wagner 2008). Until the moment of identification, there is uncertainty and there are unidentified remains, requiring name and association. It is a situation that DVI responders attempt to remedy through multiple testing and re-testing of remains, over many years, often pushing at the boundaries of available science. As DNA has transformed the identification of the dead from conflict settings (see Wagner 2008 for detailed discussion), it has resulted in calls for reassurance that multiple avenues of testing are being completed not just for the contemporary dead, but also for those from previous conflicts. There has also appeared to be a growing intolerance of a lack of confirmed identification linking a human loss to a set of biological remains, and a sense that without this certain knowledge relatives will not be able to rest (Van Veeren & Easthope 2009). This was a particular motivation behind a multitude of programmes to 'bring home'[12] US and UK war dead and to identify unidentified soldiers wherever possible.[13] The discomfort of the unidentified soldier has generated a wealth of technologies and state and non-state organizations dedicated to this aim. At the heart of this is the panacea of a DNA match: the ultimate way to get to a place of 'certainty'. The search for certainty in identification now lies at the heart of the activation of DVI, and the utilization of DNA for the specific purpose of identification has transformed the promises that can be made. Analysis of fifteen global socio-technical disasters from 1992 to 2005 captured a burgeoning enthusiasm for what was initially a novel technology but which has since developed into a mainstream science. As a practitioner, with each successive incident I was involved in, I saw a growing understanding of DNA testing implications in the aftermath of mass death. Comparing advancements in DNA technology with a chronology of 1990s-2000s disasters shows that in 1996 DNA was certified by the National Academy of Science as reliable evidence. From that point on, DNA evidence has significantly impacted upon identification protocol in disasters, particularly when identifying fragmented remains as a result of a high-impact incident. Fragmentation of the human body into multiple parts is a common feature of crashes and explosions. Put simply, with certain types

of disaster, there are usually many fragmented parts to test, even from a relatively low death toll (Mundorff 2009; 2012; 2014; Mundorff, Bartelink & Mar-Cash 2009).[14] A watershed moment in the quest for certainty through DNA analysis was the terrorist attacks across America on 11 September 2001, where the approach of mass DNA testing for identification purposes was fully embraced. Tests were applied to human tissue, animal remains, and even objects that were found later to be building materials that initially had the material appearance of bone (Blau & Briggs 2011).

As DNA has grown in popularity as an identifier, obvious attention has turned to making it faster and more transportable to the disaster scene, at both mortuary and family assistance centres (see below). In the United States, this has evolved into the Rapid DNA programme.[15] Development of the technology has been actively supported and financed by the Department of Homeland Security and the Department of Defence through a series of research and development grants over the last decade. Emphasis has been placed on both the speed of a profile result and the size/portability of the equipment. Final figures were not available on cost per profile at the time of the research, but it was described by contractors as considerably cheaper than a full laboratory-generated profile, which is the traditional approach to testing. Rapid DNA kits are available to crime laboratories as an alternative to a full DNA laboratory and are closely linked to ongoing governmental laboratory standardization work with grants available from the US Federal Emergency Management Agency to help procurement by local emergency planners. At the time of the observations that are at the core of this article, Rapid DNA was being trialled at numerous DVI exercises around the United States. The technology also has applications for kinship testing in border control settings (i.e. an airport, port, or other crossing station), on military deployments, and within police 'booking stations' when making arrests. Fellow participants in the US exercises were responders and evaluators, not just from the DVI setting, but from Department for Homeland Security border control and other law enforcement agencies. These participants were there to evaluate the potential for future use of the technology in gathering migrant DNA data in US detention centres; something that has now become practice (Silva 2019). This caused concern and disquiet about human rights infringements in exercise refreshment break times but was never overtly addressed in formal presentations.

The application in a DVI setting involves the placement of one Rapid DNA machine in, or near to, the disaster mortuary and another machine in a location such as a family assistance centre for relatives who believe their loved one may have been killed in the incident. Such a centre is a statutory requirement of transportation disaster law in the United States and so is routinely established. The aim would be to generate profiles within 90-110 minutes in each of these settings and then identify and draw together the matches. The systems are designed to be used by 'non-technical users' (i.e. not forensic genetic scientists), which in the case of the exercise meant that the family liaison-trained OMORT workers in the family assistance centre took the buccal (inner-cheek) swabs. In the US exercise mortuaries, the samples were extracted by specially trained forensic anthropologists who worked for the architects of the programme. The machines are no bigger than a table-top office photocopier and can sit on any gurney or trestle alongside sample collection bottles. They travel in a protective metal case, but one of the 'selling points' is that they are robust, do not need a totally level surface, and can survive a 4-inch drop or a liquid spill on the outer surface (as demonstrated in the field study when an enthusiastic observer spilt his coffee on the

machine). Generally, they involve one-use capillaries to reduce contamination risk. Their use is overseen by the same US standards committees for bigger crime laboratories managed through the DHS Science and Technology Capabilities Development Support Group.

I watched as the machines were greeted with overt enthusiasm from the majority of US responders, and particularly military personnel, within the exercise settings.[16] The Rapid DNA engineering teams fielded questions throughout the exercises about the limits and efficacy of the testing. Scientists and observers in the United States placed great emphasis on the 90-minute timescale for yielding a result, arguing that this was 'transformative' in terms of DVI planning and response.

In comparison, during the UK fieldwork, DNA testing on simulated deep muscle and bone was undertaken in the EUR full-scale DVI mortuary under the direction of two senior pathologists. This was all 'exercise play' with no actual samples generated and the samples were made of rubber.[17] There was therefore no 'real-time' testing of the samples in a laboratory and there were no faster DNA technologies tested here. Generally, in the United Kingdom, the samples collected are then removed from the DVI mortuary and processed in another accredited setting, with results usually taking several days and potentially longer before they are available and can be entered into the comparison process. It is therefore clear to see why portable and accessible technologies may be desirable. It is of interest to note that the United Kingdom no longer has a national forensic service and contracts awarded for DNA testing in the UK market have become highly lucrative.

In the United States, the rhetoric around the use of Rapid DNA was that it would result in a *quicker* identification than any other technology (i.e. fingerprints or dental) and that only this technology would deliver the certainty 'you' (the coroner or medical examiner) 'need'. In both the UK and US settings, there was also a strong emphasis on further 'benefits' of additional DNA testing. Commercial providers of the DNA technology in the United Kingdom emphasize as a 'selling point' that the importance of using DNA is to ensure that as much of the person is recovered as possible and that it ensures that there is no 'commingling' between human remains.[18] Contractors in both the United Kingdom and the United States stated that it was a basic human right[19] for families to have only their loved one's DNA in the human remains received for their funeral, that as much of the family member as possible would be present, and that DNA testing of all tissue, however small this might be, was the only way to guarantee this. It was also argued that it was not acceptable to provide families with only the larger fragments of their individual, and that it was essential to continue testing pieces in perpetuity, however small.

'Commingling' is one of a number of areas in DVI where responders struggle to find the words to explain their work and their priorities to families who just moments before may have learned their loved one was on the plane or in the shopping mall when disaster struck. It is almost too painful to then contemplate a conversation with relatives about the way in which their loved one's DNA may have become 'entangled' with that of another person. But behind the closed doors of mass death response, the issue of commingling is a growing preoccupation of DVI responders (see Mundorff 2014). It frequently underpins the need to procure additional expensive laboratory testing. It is important to note that this 'contamination' testing offered by commercial laboratories does not just extend to larger pieces of tissues but also involves what the US military graphically describes as the vapour-like 'pink mist' generated by explosions.

DNA testing, therefore, may be an extremely expensive, lengthy, and, indeed, open-ended process.

Once again, the attacks on 9/11 appear to have been an important watershed. Promises were made that there would be no 'hijacker' DNA in the remains returned to families after 9/11, and this has now been replicated on a number of other occasions around the world after suicide bombings.[20] This has now been extended further to promises being made by responders to families that there will be no 'perpetrator' DNA of any kind in the coffin. The concept of a 'perpetrator' is also problematic, for example, in the case of a pilot who has deliberately flown their craft into terrain. Where this has occurred to date, local prosecutors have resisted this perspective and worked with faith leaders to support relatives. When presenting my research, it was this aspect of the expressed need for separation that provoked the most interest, with many participants questioning how far these promises of cleanliness would, or indeed could, go. Would they extend, for example, to tiny fragments of wreckage from the offending plane or train that could also be perceived as a perpetrator? Some delegates raised concerns that the allure of 'a clean coffin' linked to a new secularized, science-focused, obsession with certainty should be countered by more open debate, through an anthropological and theological lens, rather than through promises of perpetual DNA testing. Others raised concerns that this preoccupation reflected fears of law enforcement agencies and scientists about how to engage with faith groups, particularly Orthodox Judaism and Islam, concerning the difficult challenges in DVI, which, in turn, may interfere with necessary religious practices concerning burial and death rites. In the UK workshops, study participants with a theological insight gave examples of priests asked similar questions after terrorist bombings in England, Northern Ireland, and Ireland in the 1980s and 1990s, predominantly perpetrated by the Irish Republican Army (IRA). The IRA did not use suicide bombing tactics, but the explosions that occured meant that body parts and tissue would become combined and families could not always have certainty that all parts of their loved one were in a specific coffin. Delegates with years of DVI response experience did cite many examples of where the question of mingling of remains, and a request for certainty that they were burying *just* their loved ones, had been raised by grieving families, so this was not a new concern of science but a long-standing societal one. These delegates emphasized that questions about 'contamination' therefore were not new, but in the past a reliance on the comforts of religion allowed society to deal differently with this issue. When priests were asked by a grieving mother about the potential that another person's tissue was also buried with them, they could reassure families that it made no difference to God. There is no doubt, therefore, that ambiguous uncertainty is a staple feature of traumatic loss. Before DNA testing in DVI, families were supported in situations of forensic uncertainty through communication and also the use in some circumstances of faith leadership or religious ceremonies, as well as the dedicated efforts of forensic anthropologists who would attempt to separate the remains of individuals as effectively as possible. Except for instances where DVI methods are applied, for many communities around the world, ambiguous loss is not commonly addressed through the use of DNA. It is not, for example, something that is offered for single deaths in any part of the United Kingdom, by procurators fiscal, coroners, mortuary personnel, funeral directors, or law enforcement officers, when bodies may also be 'contaminated' with medical waste or perpetrator DNA after a homicide or assault.

The intolerability of uncertainty

> Why would you not do anything you can, particularly if science allows it? We were going for 100 per cent certainty.
>
> Descriptions of the forensic process after the 9/11 terrorist attacks from interviews with OCME NYC personnel

There was a frequent observation of the rhetoric of the need for certainty in all of the US-based field settings and also during the interviews with the OCME in New York, and the intolerability, therefore, of a state of uncertainty. In practical terms, this means that in the laboratories of the OCME (and the linked mausoleum within the 9/11 museum) there are thousands of very small, and occasionally quite large, body parts that are being stored despite the impossibility of obtaining a DNA profile from them using current scientific methodologies. The hope is that science will one day allow DNA to be profiled from those samples and there is therefore an associated tacit promise to families that one day DNA technology will get them an answer. This may mean that bereaved families are suspended in a forensic limbo and may have to endure five, eight, and even eleven different contacts from the OCME about the discovery of 'new parts' of their loved one with 'no end' to the process (McGinty 2011; Toom 2016). Analysis of the paperwork that was provided to families in New York and in the exercise scenarios demonstrates that they are being offered 'perpetual' testing to ensure (1) that they have all available remains and (2) that there is no residual material of anybody else in the coffin. This leads to a situation of perpetual engagement between families and responders, with the relatives awaiting 'multiple knocks on the door', described vividly by Victor Toom (2016) in his analysis of this specific process. The scientists reformed the communication process during the 9/11 response so that families could choose to be informed at the start and the end rather than continually throughout the identification process, or even opt out altogether. Versions of the release form developed by the New York OCME have now been adapted for use in incidents all around the world, including the United Kingdom.[21]

I was able to observe the use of a simplified version of the form in Québec. The options that families were given included:

1. No notification at later stages (which 26 per cent of families opted for).
2. Notification and reception of remains (which 42 per cent of families selected).
3. Notification without reception of remains (chosen by 32 per cent of families). Families had the right to change their minds regarding reception of remains at notification (and one in fact did so) up until the point of interment in the ossuary (see below).

The deployment of the form in Québec was accompanied by a series of public meetings, and the coroners emphasized a further line on the form which they had added, and just as importantly communicated to families, that explained that they would be undertaking identification work to a standard that was *reasonable*, rather than 'promising that anything was possible' (interview notes, 2015).

Potential resistance to DNA dominance in the DVI strategy

> Your scientists were so occupied with whether or not they could, they didn't stop to think if they should.
>
> Ian Malcolm (Jeff Goldblum), *Jurassic Park* (1993)[22]

In Lac-Mégantic, something different to the approach taken post 9/11 was noted. Here the coroners were resistant to designing a forensic strategy which, in their words, would 'condemn' the families but also the wider and close-knit community of this small and resilient town to a perpetuity of 'not knowing'. In interviews, the coroners and the forensic anthropologists stated repeatedly that they believed perpetual uncertainty was harmful to their bereaved families and the town in which many were situated. They decided that the whole process would need an end point. They set a period of three months for anthropology examination and DNA testing, which included the genetic laboratories considered the most successful internationally for this type of work.[23] Within that time-frame, forty-one of the forty-seven deceased were matched by DNA to samples from the scene. Although the death tolls are significantly different, this is comparable to the testing regime undertaken after 9/11, where only one-third of the remains have ever yielded a DNA profile, so Lac-Mégantic was described by its responders as much more 'successful'. The cremation-level temperatures generated at both incidents and the types of remains recovered were also very similar, which explains this comparison further. The scientists in Lac-Mégantic attributed this greater success rate to the speed with which they accessed the remains and were able to gain a DNA profile. Analysis of the success of the 9/11 approach had suggested that a reason for limited success for more complicated DNA profiles had been the time that it had taken to access remains buried within the scene (Mundorff & Davoren 2014). Learning from this, the Québec coroners asked the scientists to prioritize tissue retrieval from the twelve affected buildings and two open scenes on the streets at the earliest stage. A number of the deceased from Lac-Mégantic were commingled, but the coroners in Québec explained this clearly to the family groups. Another significant difference was that the unmanned diesel train which ignited was the cause/perpetrator, so there was no individual bomber or 'perpetrator' DNA to add to the issue of 'contamination'. The forty-seven victims originated from one place, were from a close community, and therefore a narrative could be constructed that it was friends and in some cases married couples dying together. There was also a strong association between family members and the Catholic Church, with families seeking comfort from the priest who conducted all forty-seven funerals. However, the challenge, dissent, and distress that accompany these difficult conversations were inevitably still present in Lac-Mégantic, even when the malevolent force was fire-generated accident rather than any other cause. The coroners narrated that one Lac-Mégantic family member was angry with the time the process was taking and the three-month delay that was required for completion of the process, and stated at a public meeting, 'I don't mind if I get them back with other people mixed in there … I just want them back'. The responders described how as this man spoke there was a gasp from others within the audience, and some of the other families looked horrified. 'It was the mothers … you could see it on the face of the mothers … they were horrified … they just wanted their child back, no one else's remains' (interview with coroners, 2015). The responders went on to describe how they gently explained that they had to do this process and undertake the three-month joint DNA and anthropology work because 'it might be OK for your family, but it is not OK for all so we have to do it this way'. They explained that they would do 'what was reasonable … we never said we will do whatever is scientifically possible because then the process would never stop'. DNA played a part in that but so, equally, did forensic anthropology. It was the forensic anthropologist who worked to separate the remains, support the testing process, and prepare the identified victims for return to the families.

Another form of 'contamination' that the commercial DNA providers have, in recent years, suggested should be eliminated through DNA testing is the presence of any animal bone that might be recovered from the scene. In Lac-Mégantic, the forensic anthropologists adopted a scene triage approach that allowed for nonhuman bones to be identified early on in the process wherever possible, without resort to further expensive testing. This is a staple activity for forensic anthropologists. Five nonhuman items were ruled out during this initial process and a further eight items (all found to be bovine bones) were reported during the later land development process. This triage approach, and ways to ensure the success of DNA preservation and retrieval, was heavily influenced by direct communications between the Québec lead anthropologist and Amy Mundorff, who had written extensively on the benefits of adopting anthropological triage at the Ground Zero scene (Mundorff 2009; 2014).

In Lac-Mégantic a combination of DNA testing, forensic odontology (dentistry), forensic anthropology, pathology, and evidential statements allowed all forty-seven missing people to be confirmed as deceased. One missing person had no biological link to the Québec scene but narrative of his movements that night proved to be sufficient confirmation for the coroners. In the case of two sisters who burned to death that night, the fact that they were siblings meant that the one mitochrondial DNA sample recovered could not be specifically linked to one or the other. Their remains were recovered together as they died in the same bedroom, which was destroyed completely by the fire. However, here the narratives of the relatives were enough to satisfy the coroner that both girls were represented.

In situations without Rapid DNA, it is common to see dental comparisons used as a 'first-response' method of ID with DNA utilized as a further confirmatory tool, although there is some evidence that, owing to cost, the necessity of this additional DNA testing is being questioned in the United Kingdom. One practical consideration is that dentistry is only possible if there are post-mortem teeth present and if ante-mortem dental records can be accessed. The strength of DNA technology over dental comparisons is that it can work with many of the body parts that have remained after the incident (in US testing, this included simulated cheek cells, muscle, and a piece of liver), although again the need for a sample with which to undertake a comparison is needed either from the person's life or from a genetic relative. There was some disquiet amongst the forensic odontologists present in both the UK and US exercises, who were concerned that their role was being supplanted by DNA technology, and anxiety that there was too much positive weight given to the 90-minute time-scale. Speed had been a major aspect of the government tendering requirements for the Rapid DNA technology, and there was discussion that these faster DNA technologies might become even quicker. If this is the case, then these will out-perform any other scientific discipline in terms of potential speed of identification. Lord Clarke in 2001 specifically highlighted the importance of timely identification in DVI, and a fast result for an identification was a key objective in both the UK and US exercises. However, time is not everything, and perhaps allowing the process to take *at least 90 minutes* ensures the concomitant readiness of other essential *human* processes. This longer time-frame might ensure that a coronial representative is available to meet with families and, indeed, more simply, it allows family members time to prepare themselves for what the results may be about to tell them, and gather their kin to be at their side.

DNA yield can be affected by many things, and during observation of Rapid DNA technologies in US settings even 'perfect' and pre-prepared samples were affected

by fluid saturation and human error. On one occasion, an emergency responder in OMORT unplugged the Rapid DNA machine 10 minutes before the end of a two-hour run while looking to unplug their own laptop. (Fortunately, this contingency has been designed into the new iterations of system using a back-up battery.) This is no reflection on or criticism of the technology; it is simply a recognition that technologies are also at the mercy of human interaction and deviance (Easthope 2018). Further examples of error are considered below.

The terrible aftermath of 9/11 has as one of its unintended consequences a revolution in our understanding of profiling DNA *in extremis*, and there is now a huge and growing body of knowledge (see, e.g., Mundorff 2009; 2014) about the threats to DNA at the disaster scene. The environment at Ground Zero contained threats to DNA preservation in abundance: heat, water, aviation fuel, mould, bacteria, decomposition. A number of the DNA scientists interviewed in all of the research settings aired the same view: that decomposition of biological samples in a disaster was an overriding concern. Getting to the sample within the earliest window improves the chances of a profile.[24] During an interview with the New York OCME the view was expressed that quicker access to, and recovery of, human remains was the one major aspect that should have been done differently in the immediate aftermath of the attacks on the Twin Towers. Forensic pathologists, biologists, and DNA analysts, in all of the settings, gave similar answers to their perceived 'best' time-range and type of sample: usually under five days, and ideally no more than two or three days before recovery. Preferred sample type was always bone followed by deep muscle in the United States and Québec; and if it was deep muscle, then there was a request that the sample be cut down to the point of no charring and carefully swabbed to minimize contamination. In the United Kingdom, there was a particular resistance to further damage to the deceased in order to stay 'Lord Clarke Compliant', as discussed above, so while bone was desirable, generally it was 'simulated' deep muscle that was taken. However, there were of course crucial human factors to be taken into consideration here with regard to accessing human remains in a real incident: in the weeks after the attacks at Ground Zero, the Fire Department was extremely reluctant to move from an active response, where there was still hope of finding survivors, to a body recovery operation potentially using heavy lifting equipment. This was later echoed in a number of other mass fatality incidents, including the aftermath of the Christchurch earthquake in New Zealand in 2011. In Lac-Mégantic, the scene of devastation was lacking the voids and other spaces that gave responders in New York in 2001 and Christchurch in 2011 hope that people had survived. The Québec incident was immediately declared a mass fatality response. Remains were accessed as soon as possible – as one responder put it, 'We were burning our hands through our gloves; everything was still so hot' – and DNA was accessible in almost all cases (see above).

Furthermore, there are considerations here with regard to the boundaries of the incident scene and the extent to which responders go to to say that they have recovered as many remains as possible. In New York, all rubble removed from Ground Zero that could be recovered was further sifted (using fine mesh grids) at the Fresh Kills landfill on Staten Island in a further quest for human remains the size of a phalange or molar. Later, this search would be extended to sewers, roofs, gullies, and even birds' nests in surrounding buildings.[25] Remains recovered would join the other samples at the New York OCME. In Lac-Mégantic, several early advisers, including colleagues from the OCME, strongly suggested that all soil recovered from their contaminated town

centre should be further sifted for the smallest of fragments, however long this process took. Instead, the coroners set up a low-key protocol for any member of the public who thought they had discovered bones near the scene to alert their offices and there is no ongoing major search process. This was felt to be an important part of allowing Lac-Mégantic to recover from the process and crucially to allow the town's dead to rest and their families to grieve. This meant there would be an end to perpetual engagement with DVI responders. When questioned specifically on this aspect, family members of those who died in Lac-Mégantic commented on how well they thought the DNA process had been handled, and they were particularly complimentary about the communications and information received on such difficult issues (written correspondence with family, 2015). A member of the local government team working on town recovery was also asked how they would feel about an ongoing DNA testing process mirroring that in New York. They replied, 'Having an end point meant we could rebuild … the thought of this going on fifteen or sixteen years was horrifying to us … just terrible' (interview notes, 2015).

This was particularly true for the beating social heart of the town of Lac-Mégantic, the Musi-Café, which was described by the coroners as their 'Ground Zero' in the immediate aftermath. It was completely destroyed by the inferno, but fast recovery management of the contaminated scene allowed it to be rebuilt and reopen in 2015, becoming once again an essential place of relaxation and community rehabilitation (Easthope 2022).

In their interviews, the Québec coroners and the forensic anthropologists felt that in the rest of the world 'fears about commingling had possibly gone too far', and this was echoed by coroners and responders in the United Kingdom attending the data workshop. In the United States, there were also concerns raised that the forensic strategy designed for 9/11 had created a problematic and perpetual testing regime and that there was a necessary validity to questioning whether this should be repeated again. The term used most frequently by all responders in all locations was that 'a DNA genie was out of the bottle', with a few responders adding, 'Sometimes you end up wishing that you could stuff that genie back in'. All DVI responders approached, in the United States, Québec and the United Kingdom, felt that the ideal scenario for an active deployment of DNA technology would be only when time had been taken to consider a detailed forensic strategy for the incident in question. This would need to include potential negatives of the use of the technology.

The observed vulnerabilities of *all* DVI technologies to err

> So you take one sample and then another sample and they match? That's amazing.
>
> The response of an exercise attendee when the DNA technology was explained to them at Exercise MegaDeath, 2017

During the highly challenging mortuary operations activated after the Indian Ocean Tsunami in 2004, which cared for thousands of deceased from all over the world, there were a number of concerns raised about human error (Black 2018; Black *et al.* 2010). The environment that DVI teams from numerous countries found themselves in was probably one of the most challenging DVI responses that we have seen in recent times, with extremely fast rates of decomposition, differing cultural practices, heat, a lack of infrastructure, and numerous, competing protocols. The generation of DVI police trainers who honed their skills in this space have been particularly adamant

about the fact that technologies of DVI, however innovative, remain vulnerable to errors such as putting samples in the wrongly labelled bag, confusion with similar names and birth dates, or placing documents in an erroneous pile. In the studies, it was clear that in both the UK and US exercises, even in well-organized and managed facilities, error remains a high risk. Mistakes included an errant sleeve on a responder's forensic suit accidently wiping off key details on a whiteboard used for tracking of the deceased (EUR); paperwork in the scene becoming unusable due to rain (EUR; Exercise MegaDeath); exercise signs and protocols falling off walls having been taped up (EUR; Exercise MegaDeath), and misfiling of papers (both exercises). It was ironic that in two exercises separated by 3,000 miles, the same point about the need for waterproof clipboards and water-resistant 'SCUBA' paper was a prominent finding in the after-exercise debrief. In EUR, there was a scenario detail that included the birth, and death, of a baby in the field of exercise play. In reality, the baby mannequin was briefly mislaid in the body storage unit, which was not part of the scenario but became a major preoccupation for the coroner in her part of the exercise. As would be perfectly possible in a real event, the tiny infant body was found later, lost underneath an adult body bag. In a real incident, the human fallout and political and media interest in such an error becomes, understandably, highly significant. Deviation and error, and reapplication in highly localized settings, is a common theme within medical STS. Pointing out these reapplications often leads to defensive responses in the emotionally charged and masculine spaces of DVI, but they are, I contend, important examples of true, situated use of important technologies that can tell us much about the interactions between multiple stakeholders often with slightly different motivations.

The utility of effective forensic anthropology

Up-close ethnographic and qualitative research allows for the observation of personal networks, hidden actions, and 'bricolage'[26] that might be lost in broader quantitative studies of disaster practice (Easthope 2018). One aspect that exemplifies this was observing the lead forensic anthropologist Renee Kosalka at work in Montréal on the remains of Lac-Mégantic. She advised throughout the process on both the forensic and biological rigours of the process, but it was also possible to observe the community and highly individual, family implications of her advice. She worked both at the complex and contaminated scene in downtown Lac-Mégantic and then day and night at the mortuary. The coroners integrated closely with her work and their quiet diplomacy mirrored hers. It was not DNA technology that returned one of the deceased to their loved ones but 'old school anthropology', in her words. To take one example: the calcaneus (heel bone) of an adult male recovered was too badly burned to yield a DNA profile, but rather than continuing to destroy it in pursuit of a result, Renee turned to traditional forensic anthropology techniques and worked with the Forensic Anthropology Center at the University of Tennessee. She had noted the extremely large size of the heel bone and was able to build a case that it belonged to a very tall male. She provided specific quantitative analysis linking the bone to the deceased's height in life. This met the coroner's requirements, which in this place had been set, crucially, as *reasonable certainty* rather than 100 per cent certainty. The family were then able to bury this one remaining relic. DNA testing may well have destroyed it completely and yet, due to the exposure to heat, still have not provided a sample that would have resulted in an identification. Renee, like many 'anthros' in the disaster settings I have

participated in, worked quietly and humbly, and her bricolage of practice could easily have been lost without ethnographic observations.

The role of forensic anthropologists in bringing diligence and care to the scene recovery process is a crucial one (Hackman 2016; Mundorff 2012; Rosenblatt 2015; Turney 2010; Walsh-Hainey 2002). The delicate 'cremains' at the site of a fatal fire require particularly careful handling (Ubelaker 2009). In addition to all of their work with the remains themselves, forensic anthropologists are trained to gather evidence, photograph and map the scene, as well as eliminate inanimate objects such as rocks from the analysis (Christensen, Passalacqua & Bartelink 2014). Rapid DNA scientists in the United States did recognize the importance of forensic anthropologists in ensuring the success of the initial identification work, and, indeed, several development scientists for the technology were themselves forensic anthropologists. Their use in the US exercises was observed when preparing the samples identified for DNA testing, such as deep muscle, and advising on the forensic strategy.

However, what was omitted in the UK and US exercises was a recognition of the role that is played by forensic anthropology far beyond the initial DNA match. In all of the research settings, there was debate about how to ensure 'timely release' of the remains to families, with a number of discussions articulating a desire that this could be realized in under a week/a few days if the situation allowed it. DNA was perceived in these settings to be the answer to this timely release. As discussed above, further DNA testing was undertaken on the Lac-Mégantic remains, but a deadline had been set for a co-ordinated return of the deceased to all families, at the same time, after three months.

At this point, the final separating out of the remains into each individual coffin was done by a forensic anthropologist who laid (gloved) hands on each tiny, friable fragment in the same way as is done daily in Guatemala, Afghanistan, Argentina, Iraq, and Ireland when a mass grave or a location for the 'disappeared' is found (Rosenblatt 2015). This re-articulation, this placing of rib fragment with tooth with foot bone, is a lengthy, sensitive, and confronting process. As discussed above, this removal of offensive material is a further justification given for the lengthy DNA processes that human remains are exposed to after socio-technical disasters such as bombings and air crashes. As noted above, in Lac-Mégantic, DNA played a part in that work, but so, equally, did forensic anthropology. The coroners emphasized the necessity of a portfolio approach and the role of anthropology at the heart of that.

I asked about the protection given to Renee Kosalka's work and her role, and the coroners stated that they were wary from the start of overemphasizing DNA as the 'main identifier'. They said they would wish their fellow international coroners to not be afraid of reaching for other means if more appropriate in a certain setting or community (interview notes, 2015). Furthermore, forensic anthropology was able to support in the DVI process when ante-mortem harvests proved to be weak or non-existent (i.e. there was no DNA profile yielded from the victim's life from a toothbrush or retained surgical sample; no familial DNA match; or no other primary identification methods such as a record of fingerprints or dentition).

Most plans for the activation of the DVI process include the fast creation of a place in which friends and relatives are gathered. Waiting in these family assistance centres (FACs) for news and to fill in the endless Interpol forms has been described to me by bereaved families, from multiple DVI incidents, as 'the worst place in the world'. In our

twenty-first-century world, as ties of kinship are re-examined, these FACs can often initially be attended by worried friends, honorary aunties, and cohabiting partners. The attendees who are of greatest interest to the responders, however, are those with 'DNA kinship', and the most prized sample-giver of all is the biological mother with her mitochondrial DNA link to her child.

Both the US and UK exercises simulated full family assistance environments: EUR located its within a series of offices and MegaDeath's FAC was housed within a local community college. In the UK scenario, family ante-mortem interviews were undertaken by the police, and in the United States, they were undertaken by the OMORT team in private interview spaces. Real buccal swabs were taken in the US scenario and training had been provided on completing the forms and also avoiding user error and contamination.

Coroners in Lac-Mégantic who had established a real-world FAC for twenty-seven days after the fire confirmed that the interviews and buccal swabbing had taken place in interview rooms in a similar design to those that continue to be simulated in disaster exercises internationally. Theirs was housed in a new local secondary school, and pictures were provided to me of the interior spaces in the immediate aftermath. The school then allowed me to visit as it is now, bustling with teenagers.[27]

Across both sides of the Atlantic, exercise scenarios have been designed to test the interviewers with unusual family dynamics and also resistance to any DNA testing. In the UK scenario, resistance was expected (with responders appearing to echo and understand concerns about privacy), but in the United States, OMORT responders expressed surprise that anyone would resist a buccal swab in an FAC and felt that this could mean the family had something to hide (when the scenario was suggested by me). In the United States, it was apparent that while the processes for deploying the technologies and yielding the profiles are well developed, accompanying policies for socio-legal and emotional challenges when using it are not. Something as common as an adoption scenario within a family dynamic renders the 90-minute profile problematic for that family. (DNA could be potentially extracted from the missing person's hair or toothbrush, and family members may have been asked to bring that with them in advance, so their participation is still possible.) Other challenges include recent blood transfusions, bone marrow transplants, and the issues of paternity. When the issue of problematic paternity was raised in the United States, the scientists declared that they would avoid ever taking a paternal sample and opt for a maternal sample. However, having observed this myself in a real-world incident when a father was (1) the only relative at the FAC and (2) adamant that he was to be tested and distraught at the thought that he was not being allowed, this may need further exposition. In the US scenario, a husband asked to be buccal swabbed so that everything could be done to find his wife; they were not related in the scenario, but he was a non-scientist and had not understood the science of DNA.[28] In the scenario, he became distressed that nobody would swab him as he had seen other relatives being swabbed. Overall, there are no family assistance strategies currently developed at a national level, in any of the jurisdictions observed, that deal with necessary 'exclusion' from the DNA process and the emotional harm this may cause. In some cultures, the revelation of disputed paternity via the DNA process has led to substantial risk of harm to the women involved and has been an anecdotal reason provided to me for the decision to not deploy this technology in some conflict settings.

Destruction and damage to remains as part of the DNA process, and internment of remaining tissue

> What is more horrendous than getting burnt alive? You know, you ask yourself, is there anything worse? And I'm afraid there is: having no remains.
>
> Nazanin Aklani, daughter of a victim of London's Grenfell Tower fire, in an interview with James O'Brien, *Newsnight*, BBC, 12 July 2017[29]

In both the Quebéc and UK settings, the anthropologists frequently raised the issue of sample destruction or harm/mutilation of human remains in order to access material for DNA testing at the mortuary. DNA testing is often extremely destructive to any recovered and small, friable remains. The dedication, care, and protection shown by Renee Kosalka to that one heel bone was the most vivid, practical example of that in Montréal that I observed, but I was told of many more. In the UK setting, there was a detailed discussion around the necessity or otherwise of damaging the recovered remains further in order to get the necessary and best sample. In the Montréal laboratory, there was explicit and frequent discussion of the balancing act when managing the DNA process to ensure that the human remains available were not completely destroyed by testing and that some part of their family member would be available to families to bury or cremate.

Finally, in all settings, there was discussion of what to do with the fragmented remains and any 'residual' tissue that is inevitably left over if the DNA process is concluded once a single profile is retrieved for all those who are missing, rather than perpetual blanket testing of all tissue. To explain further: if the forensic strategy deems that the DNA testing will stop when a profile for all the deceased is obtained, or will stop after testing only larger pieces of tissue and bone, then there is inevitably a large collection of what forensic responders have termed 'residual tissue' when bodies are severely fragmented or reduced to fragments and fluids. In the UK exercise, there was an ongoing tension throughout the exercise duration about the sizing of residual tissue and there was a lack of clarity relating to what to do next. Via training workshops and briefings delivered by police, the United Kingdom has 'exported' to other Interpol countries an approach it developed of testing any tissue or parts over 5×5 cm in size, or any 'identifiable' parts such as fingers and teeth. The remaining tiny pieces would become 'residual' and would be destroyed.

There is often a memorial ceremony to either bury or cremate this extra tissue, but there is a dearth of policy guidance internationally on this. It does not feature at all in Interpol protocols and it is often considered outside the remit of the investigation and placed firmly back into the hands of nervous local responders. There is often another painful quandary inflicted on families on opting out of any further process or ceremonies, which is often similar to the quandary of multiple knocks on the door in the testing phase. Without a confirmed DNA result, families cannot opt out the remains from either a process or a place of storage/a monument/a tomb: they are not yours to claim, and there can be no differentiation. Families can ask to remove a name and refuse to attend, but ultimately may always wonder if some of those fragments belong to kin.

In Lac-Mégantic itself, the residual tissue (fragments that were deemed too small to test or did not yield a DNA profile) is buried alongside the majority of the forty-seven deceased in the town's graveyard within a large angel-shaped tomb. This was described by all scientists in the process as 'an ossuary', and its need and existence

were explained carefully to Lac-Mégantic residents hosted by the coroner with the lead forensic anthropologist present. The coroners and anthropologists confirmed that 27.5 pounds of residual tissue and bone are buried in the ossuary. The angel stands at the end of multiple lines of new graves of those killed in the disaster in a peaceful graveyard at the heart of the town.

Discussion

> So if we have this in the morgue, there is no need for an autopsy right?
>
> Question from delegate at Exercise MegaDeath, 2017

> How is Rapid DNA testing done? Sample in – profile out.
>
> Explanation of the RAPID DNA technology by scientists at Exercise MegaDeath, 2017

There are always complex stories behind a DVI incident. It might be a narrative of terrorism; of corporate failing and greed; of *wrong place wrong time*; or of Mother Nature reminding us of her true power. The deaths in these incidents are sudden, violent, and unnatural and deserve a full inquiry. In both the UK and US settings, there was confusion from non-forensic observers about the need for any further analysis beyond identification. In the United States, there were questions about the need for a mortuary at all, with some responders extolling the virtues of the 'field testing' approach, which would allow the deceased to be immediately released to funeral directors. In the UK setting, the pathologists specifically fielded questions from observers about the other reasons why an autopsy might be needed if they had DNA, dental, or fingerprint matches for identity. These questioners forgot the roles of toxicology, of pre-death bodily trauma, and of the body as evidence of criminal act or civil neglect. The lessons from the multiple disaster inquests and inquiries in the United Kingdom caution responders to avoid any blanket approach regarding a generic *time* of death and generic *cause* of death, and this is also specifically addressed in UK coronial DVI training. Furthermore, each family may expect a narrative of how their loved one died and discussion of the final moments. More broadly, autopsy results may be required, in detail, for both criminal and civil processes (e.g. causation and pre-death suffering is an important aspect in civil litigation but many DVI responders are unaware of this). Analysis of injuries after many global incidents have also led to improvements in areas such as building and transportation safety. In Lac-Mégantic, the scientists worked with the coroners to build up a holistic picture of the events of that night. There was also an emphasis placed on community-based narrative to finalize a picture of the deceased and their final movements. When interviewed, the coroners and forensic personnel were able to impart great detail about how they believed each of the deceased had died based on witness testimony and location of remains. An example would be that many bar-goers, celebrating a music night in the Musi-Café, appeared to have been caught by surprise by the crude oil explosion and they were found entangled in one part of the footprint. CCTV showing the explosion as well as interviews with surviving witnesses all added to the narrative of what happened to those in the bar. There was emphasis in Québec from all responders on both identification *and* investigation. Families requested remains, but they also required information, narrative, clarity, and the comfort of knowing that a full investigation into their individual loss had been undertaken.

The complicating factors that I observed in all of the exercises were devastatingly brought to the fore during the forensic response to the fatal fire in Grenfell Tower,

a London housing block, on 14 June 2017. The final data workshop at which I aired my initial findings and asked for delegates' initial responses to them was conducted approximately ten hours before the fire began. Initially, the death toll of that disaster was thought to run into the hundreds.[30] This was a highly complex scene, with temperatures that rendered the recovery of both the remains and their DNA yield complex. A number of practices did not follow expected UK DVI process (Edkins 2019). Ante-mortem harvest proved challenging and the Senior Coroner broadened the identification criteria significantly to include community narrative and CCTV which shows the victims entering the tower earlier in the day but never leaving. A large proportion of the deceased were Muslim. Many community members felt that they had a kinship link to someone in the tower, and some of the deceased were reported missing up to ninety-seven times by individuals claiming a familial or friendship tie (UK Police Casualty Bureau Presentation 2018). DNA profiles were impossible for many of the deceased, and for the forensic scientists in London it was most certainly not the panacea that they might have expected (Easthope 2017*b*). Here it was recognized that a DNA-dominated approach might provide a scientific *certainty* of identification and the certainty of a confirmed set of remains for a family to bury, but it also introduces issues that potentially prolong uncertainty and suffering: families in limbo waiting for future DNA technology to give them answers; uncovering hidden truths; and the danger of destroying remains through testing, ultimately leaving families with nothing to bury.

Conclusion

DVI processes have an overriding mission of matching the fragmented and damaged remains recovered from a disaster scene with a list of people declared missing in the incident. The processes have a number of implicit societal goals: an answer and perhaps some comfort for families; legal certainty (for purposes such as inheritance); and clarity for government agencies of who was affected and that the person has not used the incident to avoid detection or commit fraud. All DVI technologies have at their core a desire to answer what they believe is the key question posed by the incident: *who is dead?* The new DNA technologies I introduce here have brought answers and clarity for many relatives in many disasters. As a result of all of this effort and labour, many families do now have a biological link confirmed to a set of remains that can now be buried. The field responders in the area of mortuary management in the US exercises were supportive and excited about the DNA technology. There was also a clear pride in the forensic response to 9/11 from US responders and in the scientific developments that have resulted from the DNA operations there that 'are now fighting crime all around the world'. Like many technologies observed using an STS lens, the final picture is one of complexity, where much depends on the contextual application of the technology and of the approaches taken by those applying it.

Western societal efforts to prioritize DNA identification using technology that appears closely guarded and remains expensive has left practitioners open to accusations of colonialism, prejudice, and inequality; creating hierarchies of priority in major incidents and allowing resources to dictate answers to such a fundamental human right. This article has demonstrated that there are many considerations that come with the deployment of these technologies, and particularly those involving DNA analysis; ethical and legal considerations as well as societal and moral soul searching. They pose as many questions as they answer.

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NOTES

[1] I am grateful to Dr Imogen Jones for her writing on the language used when describing human remains and am mindful of her conclusions.

[2] I use 'socio-technical' to reflect the complex nature of these disasters with factors that include both human and technical/engineering interactions. For further exploration of this, see Toft & Reynolds (2005).

[3] There can also be perceived disparity inside one nation. The US forensic responders whom I met also raised an often-repeated criticism that the rigours of the 9/11 approach were not reflected in the aftermath of Hurricane Katrina, where DNA testing was discouraged in some cases due to costs. It was clear that many scientists felt that DNA DVI technologies should be available to all. Merli & Buck (2015) discuss similar disparities in relation to differences in identification efforts and care of the deceased after the Indian Ocean Tsunami in 2004.

[4] The United States operates its own disaster identification and disaster mortuary procedures, as described in this article, but does work closely with Interpol.

[5] For insight into the recovery of human remains in a scene of fire or explosion, see ENFSI (2021).

[6] At this point in the process, loved ones are missing, *not* dead. It is important that responders reflect this in their explanations and use of tense, and so on. The reported list of missing people is usually much longer than the final death toll, and often people who have been reported missing have no involvement in the incident.

[7] The most stable/consistent of the scientific methods used by responders have tended to be odontology (dental records) and fingerprinting. As this article shows, some incidents have elevated DNA matches above all else. Pathologists may also use medical information such as a very unusual physiological feature. See Black *et al.* (2010) for further discussion of this. Investigators will also collect items that may contain material that can be harvested for DNA yield, such as toothbrushes or a collection of infant dentition, as well as items that may provide finger- or footprints of the individuals. In recent incidents, examples of these have included CD cases, a bound doctoral thesis, and the tray of an infant highchair.

[8] In the aftermath of this event, there was criticism of processes adopted by police and scientists, and specifically the actions of the pathologist and the coroner (Shepherd 2018). There was particularly strong condemnation of the decision to cut off the hands of twenty-five of the deceased, which was described as a 'mutilation'. This was essentially done to make fingerprinting easier for the scientists, but some of the hands were found many years later, having been lost. The inquiry report found that no one had considered less invasive methods, such as dentistry, prior to the removal of hands.

[9] Disaster Mortuary Operational Response Team; Ohio Mortuary Operational Response Team.

[10] The exercise observations essentially take place in 'future' settings; exercise scripts and role play are often timed for later in the day on which the responders gather. Observing this 'exercise play' allowed me to observe events in the earliest stages of a DVI activation, with ethical approval to be there. This was important as although I have been part of responses to a number of *real* DVI activations in my career, ethically it was problematic to turn these into research opportunities.

[11] I explore this role and potential conflicts in depth in earlier work (Easthope 2018).

[12] The use of the rhetoric of remains 'coming home' is frequent in media accounts of these efforts (see, e.g., Ruane 2015).

[13] For further explanation on the work of the defence agency for this area, the DPAA, and its predecessor organizations, visit *https://www.dpaa.mil*.

[14] Since 1996, the number of DNA tests carried out has always outweighed the number of deaths, apart from the Kaprun cable-car fire in Austria in 2000. In 1996, there was a difference of 82 per cent in the number

of DNA tests performed on the Spitsbergen air crash in the Norwegian archipelago of Svalbard in relation to the number of deaths. In 1998, the loss of Swissair Flight 111 resulted in 229 deaths, but 1,277 fragments were DNA tested, a difference of 458 per cent. Two months after 9/11, DNA testing following the crash of American Airlines Flight 587 showed a difference of 708 per cent (Johnson 2017). More recently, DNA testing was a primary identifier for the loss of Flight MH17 over Ukraine in 2014, the loss of Germanwings 9525 in the French Alps in 2015, and the Shoreham Air show disaster in the United Kingdom in 2015. It also retained its position as a primary identifier in a series of UK terrorist incidents in 2017. It is usually deployed alongside dental analysis, as will be discussed below.

[15] For details of the Rapid DNA programme, see the US Department of Homeland Security factsheet at *https://www.dhs.gov/sites/default/files/publications/RapidDNA-508_0.pdf*. It can also be useful to put the term 'Rapid DNA' into a search engine as many relevant media and trade journal articles, with competing and conflicting perspectives, are available.

[16] There was cheering as the machines arrived and were unloaded.

[17] UK human tissue laws would not allow the use of real remains in a setting that is not licensed by the Human Tissue Authority. These laws are significantly more stringent than those of many other nations. The disparity between the United Kingdom and its forensic colleagues was illustrated in the identification processes conducted after the Indian Ocean Tsunami in 2004, when other countries would remove hands and jaws if they got to a body first. Indeed, during Exercise Heartland, real human remains were placed in the disaster scene to test both the process and the efficacy of cadaver dogs that were operating on the ground. This would not be allowed under the strict legislation in the United Kingdom. The mannequins used in Heartland were all either whole people or large body parts so the extraction of a bone or tissue sample would still result in something to return to a family. In the UK scenario, simulated testing was carried out on pieces approximately 5 cm by 5 cm, which in the scenario was the only piece of the deceased recovered.

[18] Terminology used by forensic anthropologists to describe this scenario.

[19] There currently appears to be no legal testing of this under the Human Rights Act 1998.

[20] After the suicide bombing of four transport sites across London in 2005, the police and coroner took an approach of discussing this issue as honestly as possible with families. DNA technologies were still being developed at this point, and although some testing was undertaken, it was explained to families that total exclusion of other DNA would be impossible (author's experience).

[21] Even after thousands of DNA tests, not all people on a list of missing may ever have a profile: after Flight MH17 was shot down over Ukraine in 2014, testing was undertaken for almost five years in the Netherlands but two people still had no DNA profile. The Netherlands government have committed to DNA testing any new remains recovered in Ukraine in an ongoing pursuit of those two profiles (Anadolu Agency News 2015). In this scenario, the Rapid DNA scientists explained that their technology should be seen more as a triaging tool that would generate a list of 'easy' cases quickly for responders and then the scientists could go on to focus on the more difficult cases.

[22] This iconic line is delivered in a scene where he is fiercely criticizing the actions of the genetic scientists when manipulating DNA to re-create dinosaurs.

[23] The laboratories used were the OCME in New York, the laboratories of the International Commission for Missing Persons in Sarajevo, and their more local laboratories in Montreal and Thunder Bay, Canada.

[24] Testing damaged samples for DNA yield is a growing subject of postgraduate dissertations universally and a particular focus of ongoing studies at the Forensic Anthropology Centre, University of Tennessee, in collaboration with Rapid DNA scientists.

[25] The private company that I joined in 2002 held the contract for some of this retrieval work. My role on this contract was to manage and support the staff sent over from the United Kingdom to assist, and so this was an early introduction into this area of practice.

[26] I define bricolage as the hidden, essential elements of practice conducted by responders and often behind closed doors: 'the bits and pieces of doing' (Easthope 2018).

[27] The school building was newly built and not used before as a school. It first opened to pupils a month after it was used as the FAC. This was part of the coroners' considerations as they said that if the school had been a long-standing institution, and possibly the place where the deceased had been educated, it would not have felt the right place and could have added to family distress.

[28] I had encountered this at several earlier points in my career and had even known of occasions when police officers had buccal swabbed husbands or wives because they, too, did not have the necessary understanding of the workings of DNA genetic matching.

[29] The video can be viewed here *https://www.youtube.com/watch?v=eANrDnyecSw*. See also Edkins (2019) for further discussion of this point.

[30] The Metropolitan Police and Senior Coroner have finalized the death toll at seventy people on the night and a thirty-week gestation baby who died in utero, as well as a further casualty who died some months later (Chaplain 2018).

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Incertitude médicolégale, vestiges fragiles, et l'ADN comme panacée : observation ethnographique des difficultés de l'identification des victimes de catastrophes au XXIe siècle

Résumé

L'autrice rapporte une recherche ethnographique portant sur les processus scientifiques spécialisés regroupés sous le nom d'*identification des victimes de catastrophe* (IVC), dans trois contextes : au Québec, aux États-Unis et au Royaume-Uni. En cas d'événement causant la mort de nombreuses personnes, une série d'actions est mise en branle et une pléthore d'outils employée sur le lieu de la catastrophe, dans les laboratoires de médecine légale, les centres de soutien aux familles et les chapelles ardentes. L'autrice examine ici un processus dont le but est de faire le lien entre la dépouille biologique d'une personne décédée et la validation confirmée de sa personnalité. Elle décrit une situation dans laquelle sauveteurs et scientifiques testent à de multiples reprises des restes humains, repoussant souvent les limites des méthodes scientifiques dont ils disposent. Elle avance que la recherche d'une identification certaine, notamment par des tests d'ADN, est au cœur des processus d'IVC activés. Par l'observation de cadres médicolégaux intimes

et du bricolage qu'est le travail des anthropologues forensiques, l'autrice a pu retracer la production de la science de l'identité. Elle étend ensuite sa réflexion aux implications plus larges de ces observations pour les communautés affectées et les scientifiques intervenants. Enfin, elle fait remarquer la complexité et l'ambivalence entourant l'usage accru de la technologie pour l'identification des victimes.

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