DNA-based identification of victims of the Mangalore air crash of May 2010

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The crash of a passenger aircraft at Mangalore on 22 May 2010 resulted in the loss of 158 lives. The district authorities handed over to claimant relatives, the remains of 136 victims whose identification was based on morphological features of, and/or personal effects on, the victims. The Centre for DNA Fingerprinting and Diagnostics undertook DNA profiling of the 22 remaining victims for comparison with DNA profiles of 32 claimant relatives. This analysis permitted the identification of 10 of the victims, whereas for the other 12 victim remains, it was conclusively shown that they were not the biological relatives of any of the claimants. These data indicate that in this disaster, which would be categorized as a closed system, several of the original identifications of the victims (prior to DNA testing of the remainder) had been erroneous. The policy implications of this exercise are discussed with regard to the formulation of disaster management plans in the country.

Keywords: Disaster management, DNA profiling, Mangalore air crash, victim identification.

IT was just as the sun was rising above the horizon at the Mangalore airport in South India on 22 May 2010 that the Air India Express flight IX812 arriving from Dubai tragically overshot the runway to plunge into a valley, with the aircraft disintegrating and bursting into flames in the process. Among the 166 people on board, one woman and seven men managed remarkably to jump out of the wreckage and thus survived; the remaining 158 individuals (including the six crew members) were killed in the disaster, all but one of them (the pilot) of Indian nationality.

The procedure currently adopted in our country for the identification of disaster victims is based on recognition by kin of morphological features and personal effects such as clothing or jewellery but these become increasingly difficult to employ where victim remains have been charred, mutilated or decomposed. In the developed world, dental records have been extensively employed for disaster victim identification; however, such records are scarce in developing countries including India, and it has been suggested that DNA-based identification would be more effective in these situations[1,2]. In the last few years, the Centre for DNA Fingerprinting and Diagnostics (CDFD) has been working with the National Disaster Management Authority on formulation of guidelines[3] for DNA profiling-based victim identification, and two of us (M.R.N. and S.P.R.P.) rushed to Mangalore to obtain body samples for DNA analysis from victims and their claimant relatives.

In disaster parlance, an air crash is an example of a closed system in which victim identification is constrained within a set of known individuals (as listed in the passenger and crew manifests); in contrast, disasters such as rail accident, fire in a cinema hall or commercial complex, cyclone, tsunami or terrorist attack, are examples of open systems where the identity of all individuals who were present at the site of disaster may not be known. In the Mangalore disaster, the standard procedure was initially adopted by which relatives sought to identify (based on body features and personal effects) and to claim the mortal remains of the victims, and the body remains of 136 victims were handed over to the claimant relatives in this manner.

In the case of the remaining 22 victims (including three of the crew), either the relatives were unable to recognize features for identification with any degree of confidence or there were competing claims for a single set of remains from more than one family. The decision was therefore taken to attempt DNA-based identification of the 22 victims by comparison of their DNA profiles with those of 32 relatives, the vast majority of the latter being either parent, child or sibling of the victims.

DNA preparations were obtained and analysed from body samples of the relatives (blood) and of the victims (tooth from one case, muscle or liver tissue from the remainder), with the aid of commercially available kits and according to the manufacturers' instructions (Promega Corp., USA and Applied Biosystems Inc., USA). Three sets of DNA profiles were generated: (i) canonical profiling by multiplex PCR at 15 autosomal microsatellite loci and the amelogenin locus on the sex chromosomes, done for all victims and claimant relatives; (ii) profiling by multiplex PCR at 17 Y-chromosome microsatellite loci, done for all victims and all the male relatives, and

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(iii) mitochondrial DNA sequencing of the hypervariable-1 and hypervariable-2 loci, done for DNA samples from all body remains that had remained unidentified, and likewise from all those relatives whose kin remained unidentified, after the tests at (i) and (ii). Autosomal DNA profile comparisons enable the establishment especially of parent–child relationship (in which there would be at least one matching allele at each of the tested loci) and less efficiently of relationship between pairs of siblings (in which there would be 50% identity statistically, but in individual cases, the identity could vary from 0% to 100% along a Gaussian frequency distribution curve); Y-chromosome profile comparisons of patrilineal or 'Sagotra' relationships (father–son, brother–brother, etc.); and mitochondrial DNA sequence comparisons of matrilineal (mother–child) and sibling (including brother–sister and sister–sister) relationships.

A critical requirement for disaster victim identification is that it should be done expeditiously so that the body remains can be handed over to the grieving relatives for performance of last rites without delay. Based on autosomal and Y-chromosome DNA profiling data, we were able to establish the identities of 10 of the body remains within 48 h, and of one more a day later. Three of these cases exhibited certain features of interest.

In one, the victim was identified as the brother of two claimants (themselves brothers), but since the latter had lost two brothers in the crash (neither of whom had been identified prior to DNA testing), it was not possible to distinguish, based on DNA evidence alone, the identity of the remains between the two sibling victims. Likewise, in a second case in which a victim profile matched that of a claimant male relative, the latter had lost several of his family members including his father and a brother in the disaster and it was not possible, based on DNA evidence alone, to unequivocally distinguish whether the remains were those of the father or the brother; at the same time, it was suggested that the remains were probably those of the father, since the requisite condition that at least one matching allele at each autosomal locus exists under such an assumption was fulfilled between the victim and claimant relative DNA profile. Finally, one of the body remains exhibited a Y-chromosome match with a claimant father, based on which it was suggested that the victim was patrilineally related to the claimant; however, the family members in this case were convinced (based on morphologic features) that the remains were not those of the son and declined to claim the same.

Following upon the positive determination of identities of several victims as described here, it was also conclusively established from the DNA tests that the remaining 11 sets of body remains were not from the biological relatives of any of the claimants. This suggested that, in at least 12 instances in this closed system (if one counts the victim who was patrilineally related to but was not the son of a claimant father), other body remains had been mistakenly identified and claimed by relatives based on morphologic features and personal effects, before the DNA tests were done on the remaining victims. Conclusive establishment of non-identity in these cases required the generation of mitochondrial DNA sequence data from the victims and relatives and could be completed only one week after the positive identifications had been reported. Last rites for the 12 unidentified victim remains were then conducted by the public authorities as per established norms.

In conclusion, this exercise represents, to our knowledge, the first in this country wherein DNA-based identification of victims from a mass disaster was undertaken in a time-sensitive manner. Based on this experience, we wish to offer the following suggestions for the handling of similar events that may occur in future.

- Procedures for DNA-based victim identification should be incorporated as standard operating protocol in all disaster management plans[4]. This would also require the substantial expansion of the volume of routine DNA profiling activities being done in the country at present, so that adequate resources and personnel could be requisitioned in an emergency situation such as for disaster victim identification.
- For ease of victim identification by DNA testing, the preferred relatives for comparison would be parents or children of the victims.
- Mortal remains of victims may be released to families only after suitable and authentic identification is completed. If this is not practicable in any given disaster situation, at least the tissue samples from each of the victims must be taken at the time of autopsy for retrospective establishment of identities by DNA analysis.
- Finally, suitable arrangements should be made for preservation of mortal remains until the identification process is completed (e.g. by having a stock of portable refrigerated caskets available as part of disaster management plans). The lack of such facilities was a problem faced by the public authorities in Mangalore.

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