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REVIEW

Underwater disaster victim identification: the process and the problems

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Abstract An underwater disaster may involve a crime scene investigation which should be handled as if it were located above water and include a detailed description and documentation of items, belongings and findings. The environment, however, creates special circumstances, each with specific problems that are not encountered during land investigations. Risks associated with underwater recovery cannot be overestimated and underwater disaster recovery diving should not be performed without special training and careful pre-dive planning. Handling of cadavers in an underwater recovery operation also requires special training and a systematic approach to victim recovery. Environmental circumstances, local judicial requirements, religious and cultural issues and the scope of the disaster are only some of the factors that have to be considered before commencing any aquatic disaster victim recovery operation.

Keywords Disaster victim identification · Underwater · Diving · Aquatic

Introduction

All over the world people are daily transported on ships, ferries and boats across rivers, oceans and seas. Maritime accidents, as with any major disaster, will have a deep and lasting impact on the communities affected, with many people dead, injured or missing. Recent years have also provided history with airplane crashes into the ocean. Acts of war will not be mentioned in this article but the approach in methods of identification should not be different. Disasters involving vessels are unfortunately not a recent event and history provides us with many examples:

- The RMS Titanic sank on her maiden voyage in 1912 and 1,517 perished in the frozen waters of the North Atlantic. The bodies were not recovered.
- In 1915 the SS Eastland sank in the Chicago River with a total of 845 passengers and crew lost.
- The MS Herald of Free Enterprise, a car and passenger ferry, capsized just after leaving Zeebrugge, Belgium in 1987 with a loss of 193 passengers and crew.
- Air Florida Flight 90 crashed into the Potomac River in 1982, killing 78 people.
- In 1991 an Egyptian ferry, the Salem Express, sank off the coast of Egypt with 464 fatalities. The bodies were recovered and buried on land.
- In 1994, the MS Estonia sank in the Baltic Sea, claiming 852 lives. The wreck was declared a grave without a recovery operation being performed and diving is no longer permitted on the site.
- In 2002, the MV Le Joola, a Senegalese government-owned ferry, capsized off the coast of Gambia resulting in the deaths of at least 1,863 people.
- In 2006 the al-Salam Boccaccio 98, sank in the Red Sea. The ship had up to 1,400 people on board with only around 300 being rescued.
- The Princess of the Stars capsized in 2008 off the central Philippines. Over 700 of the more than 800 passengers aboard perished in the disaster. The cargo

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Fig. 1 Princess of Stars capsized due to typhoon Frank on 21. June 2008, approx. 200 km South of Manila by the Sibuyan Island. Over 700 of the more than 800 passengers aboard perished in the disaster, and the cargo also included large quantities of highly toxic pesticides

also included large quantities of highly toxic pesticides (Fig. 1).

- Air France flight 447 from Rio de Janeiro crashed into the Atlantic Ocean in 2009, killing 228 on board.

An underwater disaster may involve a crime scene investigation which should be handled as if it was located above water and include a detailed description and documentation of items, belongings and findings. The environment, however, creates special circumstances, each with specific problems that are not encountered during land investigations.

Process

A proper crime scene investigation on land always includes a very detailed description of the position of the decedents, together with documentation of items, belongings and other findings in relation to the bodies. There is no reason why an underwater crime scene investigation should be conducted differently. Methods and procedures have been developed [1, 2] to process crime scenes underwater and these methods are being used by law enforcement officers in the United States [2]. These methods involve the handling, bagging and securing of dead bodies under water.

Handling and securing a body under water is often a difficult and demanding task as working conditions may be challenging with poor to no visibility, location of the bodies at considerable depths and associated hazards from currents and surrounding objects. Diving is always dangerous under non controlled circumstances and divers should not be exposed to additional risks during any recovery operation. Careful planning of dives with a strong focus on safety for divers participating is an important part of underwater criminal investigations.

Handling of cadavers in an underwater recovery operation requires special training. Bagging of cadavers should be carried out the same way each time to assist the pathologist in assessing any injuries found on the body. Evaluation of post mortem injuries is the responsibility of the forensic pathologist and can be of vital importance in a criminal case. The area surrounding the cadaver should be carefully examined and documented together with a record of the depth where it was located. A marker should be placed to enable investigators to revist the scene if needed and search through the sand/bottom material for items belonging to, or associated with, the deceased.

An underwater search includes a search for body parts and organs as DNA examination of these could assist in identification of victims [3, 4]. Recognition of human tissues under difficult circumstances including poor visibility and confined spaces requires special knowledge and training and the psychological impact on the divers performing recovery work has to be taken into consideration at all times. The psychological welfare of divers involved in a possible recovery operation was intensively discussed in the Swedish media after the MS Estonia accident, but in this case the wreck was declared a grave site without a recovery operation being performed and diving is no longer permitted on the wreck.

Other risks associated with underwater recovery cannot be overestimated and underwater disaster recovery diving should not be performed without special training and careful pre dive planning.

The majority of positive identifications of victims from a maritime disaster are achieved by dental examination [5] and it is generally accepted that up to 60% of victims can have dental results as the primary identifier. The numbers are, of course, heavily dependent on the availability of ante mortem dental records [6] and in many parts of the world records of dental procedures performed are not suitable for disaster victim identification purposes.

Handling of a fragile cadaver under water has to be performed taking into consideration the potential for detachment of limbs, and in the worst case scenario, detachment of the head or lower jaw with the potential loss of teeth or other identifiable features such as surgical implants, fillings or prostheses. It is however important to emphasise that the method of identification cannot be decided upon until the body is out of the water, and has been examined by a forensic pathologist, fingerprint experts and forensic odontologist in line with Disaster Victim Identification (DVI) examination standard procedures. Interpol and the ICRC have produced DVI Guidelines to assist examiners in the identification of disaster victims [7]. Post mortem information is entered into the

appropriate software and matched against existing ante mortem data in a standard manner [6, 7].

Any manual examination of a cadaver by a forensic pathologist or odontologist should be preceded by computer assisted tomography (CAT scan) if possible. Careful planning is therefore of the essence, as the identification process relies upon sequential steps that provide accurate information. Lack of planning can prolong and complicate the identification process [8–10]. Special water cadaver bags that can be used in a CAT scan are required as cadavers may be quite fragile and should not be transferred between bags once placed in the initial bag. The potential risk of losing vital identifiers when shifting bodies between bags has to be considered. CAT scanning has become a vital part of disaster victim identification [11] and should be performed on all material collected during a recovery operation. Bags from the scene/disaster area should be placed in the CAT scan without prior opening and the image material from the digital autopsy, digitopsy, (CAT scan examination of deceased = digitopsy) analysed. This approach enables the identification of skeletal elements in heavily disrupted body masses. Personal effects together with other identifiers such as teeth and surgical implants can easily be recognised and recovered [12, 13].

The digital image material acquired during CAT scanning (digitopsy) should be stored in a secure manner for future use as it could play a vital role in a possible future criminal investigation [14].

Methodology

A diving team should consist of trained, well equipped divers and the entire operation has to be planned with a focus on the recovery of all of the decedents, the integrity of evidence and the safety of all personnel involved in the operation. The team must be led by a team leader and a non diving medical officer should be present during the entire operation to ensure rapid medical of the divers in case of an accident.

The leader of a diving team is based above water and should not enter the water during the recovery phase of the operation. His or her primary responsibility is the safety of the divers in the team and to ensure that protocols are followed. Divers should be equipped appropriately for the operation. Basic scuba equipment such as BCD (Buoyancy Control Device), air tanks and weights are used but consideration will also have to be given to the nature of the disaster scene. Circumstances might influence the type of protection worn by the divers and potential chemical hazard waste from a sunken vessel could even prevent divers from entering the water. The scene should always be assessed by appropriate experts before any recovery work

Fig. 2 Diver equipped with a full face mask and dry suit to dive in potentially contaminated water. A full face mask will also allow wireless underwater communication

is started. Vulcanised dry suits and full face masks should be available and divers need to be familiar with this equipment in case it is needed (Fig. 2). Pre operation training is strongly recommended to minimise delays during the recovery work and to ensure the safety of the divers. The usage of Enriched Air (Nitrox) has to be evaluated and the potential benefits of this approach with increased bottom time and shorter surface intervals could be important for the performance of the dive team.

Before practical recovery work begins it is recommended that the team leader does an assessment dive so that he/she can inform and brief the members of the dive team regarding the dive site and what they might expect during the recovery work.

Underwater body recovery

Mark the location of the body

The initial search for a body in water is complicated by numerous factors [15] and in a large disaster with many dead this can be a lengthy and time consuming operation. When a body is found underwater the diver should mark the location with a buoy, attach the buoy to the body, or something close to the body, and release the device to the surface. Depending on the depth the diver can then follow the line to the surface so that the location can be triangulated and documented at the surface. If the body is located at a significant depth, ascent and descent by the diver might not be practical or safe, and another approach should be instituted before the recovery operation starts. When bodies

are located inside a vessel a different approach is required and a drawing of the vessel with outlined compartments will enable structured documentation of the position of findings.

Photographic documentation

The location of the buoy should be documented together with the associated underwater findings. If visibility permits, the area around the body and the exact location of the body should be photographed. If photography is not possible the diver should draw a sketch of the scene and it is the responsibility of the team leader on the surface to make sure this is done before the diver enters the water again.

Search for further evidence

The area around the decedent should be searched for personal belongings, body parts or other items vital to the identification process or possible criminal investigation. Locations of items are documented and items should be carefully bagged or placed in plastic tubes under water to ensure the integrity of the evidence. The search for evidence can be performed while the body is still under water but if the location is properly marked and circumstances allow, the diver could first bring the body to the surface and then descend, following the buoy line, back to the marked location for an extended search.

Bag the deceased underwater

When practical, bodies should be bagged underwater (Fig. 3). This approach will minimise the loss of physical evidence and make the recovery of the body to the surface easier. Again, adaptation to the local environment and conditions is vital to ensure the safety of all personnel involved. During recovery of victims from the Princess of the Stars in 2008, body bags were filled with air under water to bring them to the surface (Fig. 4). Once a body is brought to the surface, use of a stokes basket is recommended to lift the body out of the water. A stokes basket will minimise the physical effort (important during a long recovery operation) and the lift of the body will be conducted in manner that ensures safe handling of the deceased.

Further search if necessary

Depending on the initial approach, the complexity of the scene, and the depth and number of divers, an additional search of the location should be performed. Sieving the bottom material may be necessary, looking for personal belongings, as well as hair, teeth, bones, or other items important for the identification, as well as for possible criminal investigation.

Fig. 3 Handling of cadavers under water requires special training. It is essential that the cadaver is handled according to established procedures to allow proper assessment of injuries found by the pathologist

Fig. 4 During recovery of victims from the Princess of the Stars in 2008, body bags were filled with air under water to bring them to the surface where they were collected and lifted out of the water

Conclusion

Recovery and identification of deceased individuals "…represents the fulfilment of the right of human beings not to lose their identities after death…" [16]. Securing of any crime scene (under or above water) is therefore important and ensuring the integrity of physical evidence as well as potential human identifiers is vital at any stage of a disaster investigation. Detailed planning and a careful approach will minimise errors and ensure a more successful outcome [8].

Crime scene diving also requires planning and training. Performed accurately, it will ensure that the information gained will add crucial data to any criminal investigation. In a DVI mission performed at sea or anywhere under water, divers have the task of securing personal belongings, locating documents and determining the position of victims, in addition to safely recovering bodies and searching for other items vital to the process of identification.

The diving team consisting of trained, well equipped divers, should be led by a team leader based above water during the entire operation. The recovery work should follow an initial assessment of the environment in which the divers will work. A structured approach to the task is important and pre dive training is strongly recommended.

Establishing drowning as the cause of death on victims in a maritime disaster can be difficult, as diagnostic features of drowning are lacking [17–19]. The standardised identification procedure recommended by Interpol [7] allows the forensic pathologist to perform a proper medico-legal examination and this approach will ensure that any injuries, signs of violence or other clues as to the cause of death, as well as manner of death, are brought to the attention of all relevant investigators.

Environmental circumstances, local judicial requirements, religious and cultural issues and the scope of the disaster are only some of the many factors that have to be considered by authorities to guide a DVI team in their work to assist in the positive identification of the deceased [8].

Keypoints

1. An underwater scene investigation can add valuable information to the DVI process.
2. An underwater disaster victim identification operation requires careful pre dive planning.
3. A structured approach to underwater scene investigation is vital for accurate collection of physical evidence.

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