Chapter 7
Anthropologist-Directed Triage: Three Distinct Mass Fatality Events Involving Fragmentation of Human Remains

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Introduction

Identifying victims from mass fatality events requires the synchronization of several processes including, but not limited to, recovery, antemortem information collection, mortuary processes, death certification, family assistance, and finally, repatriation. This chapter will discuss one small aspect of the mortuary process, triage, and its interplay with other aspects of the process of identifying highly fragmented remains. Specifically, this paper will focus on anthropologist-directed triage and how it differed during the World Trade Center (WTC) disaster, the crash of American Airlines Flight 587 (Flight 587), and the crash of the Staten Island Ferry. Each of these incidents involved significant variation in the number of victims, the number of recovered human remains, their degree of fragmentation, site characteristics, and recovery processes. Each of these considerations affected the triage teams' composition and duties.

Triage

The Oxford English Dictionary defines triage as "the actions of sorting according to quality", "to pick, cull, ... the assignment of degrees of urgency ... in order to decide the order or suitability of treatment ..." (1989). The term "triage" was commonly used in the early 1700s when describing the sorting of wool in degrees of fineness and quality. The military has also used triage to rank injured personnel in accordance to the seriousness of their injuries, ensuring the most critically injured are treated first. As applied in this chapter, the term "triage" encompasses the first assessment human remains receive once they have been recovered and transported to a mortuary or temporary mortuary facility. Actions performed during the triage examination can differ greatly depending on event characteristics. But the central feature in any mass disaster triage situation involves sorting, or culling, material useful in identification from material that is not.

The triage station is usually the first stage of the mortuary process in high-fragmentation mass fatality events (Mittleman et al. 2000). Traditionally, an

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anthropologist or pathologist directs triage, depending on the disaster type and the condition of the remains. The triage team is empowered to sort out commingling, identify and discard nonhuman remains, rearticulate or reassociate disparate pieces within a body bag, and anatomically identify fragments for later examination. Because an in-depth understanding of human skeletal anatomy drives all of these activities, triage of fragmented remains is most effective when directed by an anthropologist (Byrd and Adams 2003; Levinson and Granot 2002; MacKinnon and Mundorff 2006; Rodriguez 2005).

Every disaster is unique, and each incident's individual characteristics will determine triage team composition, how it functions, and where it is integrated into the identification process. Characteristics directly influencing the triage process include the number of deceased, degree of fragmentation, and taphonomy of skeletal elements recovered (Alonso et al. 2005; Leclair et al. 2004; Rodriguez 2005). It is well recognized that site characteristics, recovery-induced commingling, trauma inflicted by digging activities, and improper and unscientific recovery techniques complicate mortuary analysis (Egana et al. 2005; Sledzik and Kontanis 2005; Tuller et al. 2005). These are some of the problems that are recognized and addressed during triage.

The Three Disasters

In each of the three disasters, human remains were first collected at the disaster scene and transported to the OCME in Manhattan for processing and identification. Upon reaching the Medical Examiner's Office, remains from all three incidents were examined at a triage station, which was directed by a forensic anthropologist. This was an important first step in the lengthy identification process. Significantly, the unique characteristics of each mass fatality required that the anthropologist's role at triage be tailored to that specific incident (Table 7.1).

World Trade Center

At 7:59 on the morning of September 11, 2001, American Airlines Flight 11 left Boston's Logan International Airport en route for Los Angeles, carrying 81 passengers, 2 pilots, and 9 flight attendants. The aircraft was hijacked shortly after departure, diverted to New York City, and flown into the North Tower of the World Trade Center between the 94th and 98th floors at 8:46 a.m. Hundreds of people were killed immediately and hundreds more remained trapped. At 8:14, United Airlines Flight 175 also left Boston's Logan International Airport bound for Los Angeles, with 56 passengers, 2 pilots, and 7 flight attendants on board. This plane was also hijacked shortly after departure, was also diverted to New York City, and was flown into the South Tower of the World Trade Center between the 77thto 85th floors. Again, hundreds of people were killed instantly and hundreds more remained trapped.

Table 7.1 Factors Influencing Triage Protocol for Each Disaster

World Trade Center	American Airlines Flight 587	Staten Island Ferry
Open population	Closed population	Open population
2,749 Victims	256 Victims	11 Victims
~20, 000 Fragments recovered	~2, 100 Fragments recovered	~35 Fragments recovered
8 Months recovery duration	Days recovery duration	Hours recovery duration
Recovery personnel untrained in forensic arch/anthro	Recovery personnel mixed with medicolegal trained staff	Recovery personnel directed by medicolegal staff
Buried site, heavy machinery used	Surface recovery	Surface recovery
Unlimited resources	Unlimited resources	Unlimited resources
High Type 1 (recovery) commingling	Medium Type 1 commingling	Low Type 1 commingling
High Type 2 (disaster) commingling	Low Type 2 commingling	No Type 2 commingling

According to *The 9-11 Commission Report*, on September 11, New York City and the Port Authority of New York and New Jersey mobilized the largest rescue operation in the city's history (2004). At 9:58 a.m., less than one hour after impact, the South Tower collapsed in approximately 10 seconds, killing all remaining civilians, first responders, and emergency personnel who were still trapped inside. At 10:28, 102 minutes after impact, the North Tower also collapsed. Again, all remaining individuals in the building, except for 12 firemen, 1 Port Authority police officer, and 3 civilians, were killed.

Two thousand seven hundred and forty-nine victims lost their lives in the September 11, 2001, World Trade Center disaster. Five years later there have been 20,730 fragments of human remains recovered from the disaster site and the landfill operation. Identification efforts with these remains have led to the accounting of 1,598 of the victims, or 58% of the missing. Because many remains were either completely pulverized in the towers' collapse or consumed in the fires that burned at the site, there are victims of whom nothing is likely to be recovered. As of September 11, 2006, 10,933 of the recovered fragments have been identified, approximately 53%, leaving 9,797 fragments unidentified. As of this writing, the identification process continues and these numbers are likely to change.

After recovery, the initial sort of human remains takes place at the triage station. This sorting becomes increasingly complicated as the number of victims and their degree of fragmentation increases (Rodriguez 2005). The World Trade Center disaster is by far the most complicated of the three disasters to be discussed. As previously mentioned, there were 2,749 victims and over 20,000 fragments of human remains. This number does not include thousands of nonhuman remains that were recovered but discarded.

The World Trade Center site characteristics presented unprecedented challenges to recovery personnel. Because the remains were not scattered across the landscape, as often seen with aviation accidents, but were buried within the debris of 7 destroyed buildings covering over 16 acres, Ground Zero might best be analogized to a typical buried archaeological site. The debris mound, often referred to as "the pile," stood 70 feet above ground and was later excavated 70 feet below ground. And like an archaeological site, all of the excavated debris was sifted to recover artifacts, or in this case, human remains. Excavating Ground Zero took approximately 8 months and workers spent an additional month to finish sifting through the debris sent to the Staten Island Landfill.

American Airlines Flight 587

On November 12, 2001, American Airlines Flight 587 crashed into a residential neighborhood in Queens, New York, approximately 90 seconds after takeoff from John F. Kennedy International Airport. The flight, en route to Santo Domingo, Dominican Republic, held 251 passengers, 7 flight attendants, and 2 flight crew members. All were killed, as were an additional five people on the ground. According to the National Transportation Safety Board,

> The probable cause of this accident was the in-flight separation of the vertical stabilizer as a result of the loads beyond ultimate design that were created by the first officer's unnecessary and excessive rudder pedal inputs. Contributing to these rudder pedal inputs were characteristics of the Airbus A300-600 rudder system design and elements of the American Airlines Advanced Aircraft Manoeuvring Program. (NTSB 2004)

The crash of American Airlines Flight 587 occurred 2 months and 1 day after the World Trade Center disaster. Already on high alert for terrorism, the City of New York responded quickly with a wide variety of personnel from the Police Department, Fire Department, Port Authority, FBI, and the Medical Examiner's Office. Initially, the crash was thought to be related to terrorism, and law enforcement personnel were assigned to recover the human remains. The remains and airline wreckage were scattered over several blocks, destroying four homes and damaging six others. Due to the easy accessibility of the crash site, all of the approximately 2,100 fragments of human remains were recovered within days.

Taphonomically, the remains recovered from the crash of American Airlines Flight 587 differed drastically from the WTC remains. American Airlines Flight 587, with 256 victims, involved approximately 2,100 fragments of human remains. Although the victim-to-remains ratios between Flight 587 and the World Trade Center disaster were very close—approximately 7.5 remains recovered for every victim—the disaster sites, recovery periods, and condition of the remains differed substantially (Brondolo 2004). In contrast to the remains at Ground Zero, Flight 587 remains were not buried, but scattered on the surface, destructive machinery was not used in recovery, and the remains suffered little secondary damage. Also, where the WTC excavations lasted months, this collection took days, and the fuel-induced fires at this crash site burned for hours, not months as at Ground Zero. Finally,

the short recovery period meant that decomposition did not set in as it did during the prolonged World Trade Center disaster recovery. All of these factors directly affected triage protocols and identification success rates.

The Staten Island Ferry Crash

On October 15, 2003, the Staten Island ferry *Andrew J. Barberi* ploughed into pier B-1 killing 11 passengers. Although this ferry carries up to 6,000 passengers, the accident occurred before evening rush hour and only an estimated 1,500 passengers and 15 crew members were on board. With an annual ridership of 19 million, the Staten Island Ferry is second only to Seattle, Washington, as the largest U.S. urban ferry operation. That day, the ferry made its standard 5.2-mile trip from Manhattan to Staten Island, a trip that usually takes about 21 minutes traveling at approximately 15 knots (NTSB 2005).

The National Transportation Safety Board investigation concluded that the probable cause of this accident was "the assistant captain's unexplained incapacitation and the failure of the New York City Department of Transportation to implement and oversee safe, effective operating procedures for its ferries. Contributing to the cause of the accident was the failure of the captain to exercise his command responsibility over the vessel by ensuring the safety of its operations" (NTSB 2005).

The Staten Island Ferry crash will be the third mass fatality event discussed and contrasted. This incident involved 11 fatalities, approximately 35 fragments, and 10 near-complete bodies. These remains were recovered within a few hours, this time under the direct guidance of medicolegal staff from the Office of Chief Medical Examiner, NYC. This was also a quick recovery of predominantly surface-scattered remains. This incident involved substantially fewer victims and a lower victim-to-remains ratio (approximately 3.5 remains recovered for every victim) than the other two incidents profiled in this chapter. Reflecting this reality, the subsequent triage process was comparatively simple. Unlike the remains from Flight 587, these were not burned. Additionally, because they were relatively recognizable, were not buried or decomposed, and were not as severely fragmented or commingled, they shared more taphonomic similarities with the Flight 587 remains than with those of WTC.

The World Trade Center Disaster

Open vs. Closed Population and DNA Testing Decisions

Often, mass disasters are categorized as either having a closed population, where the number and names of the victims involved are known, or an open population, where this information is not available. The crash of American Airlines Flight 587, with a passenger list, was considered a closed population, while the Staten Island

Ferry crash was considered an open population. The World Trade Center disaster was both. Although investigators were provided passenger manifests for the two planes that hit the buildings, as well as rosters of other probable victims, the actual number and names of the victims in the towers remained unknown. The process of generating an accurate missing persons list with an open population is slow and complicated, and it took nearly 3 years to compile a final fatality list for the WTC disaster (Brondolo 2004). In light of the unknown number of victims and the degree of fragmentation, the Chief Medical Examiner, Dr. Charles Hirsch, decided to DNA-test every piece of human remains no matter how small. Establishing this standard assured that no possible victim profile would be missed. Fulfilling this standard necessitated an exacting triage process, requiring the detection and dissection of small bone fragments that had become embedded in other fragmented remains.

The decision to DNA-test every fragment was unprecedented. Investigators in mass fatality incidents generally do not DNA-test every fragment and criteria, for determining which pieces to test varies from incident to incident (Holland et al. 2003; Hsu et al. 1999; Meyer 2003; Mittleman et al. 2000; Olaisen et al. 1997). In an incident with an open population, such as the London Underground bombings of July 7, 2005, investigators considered both the remains' size and relative identifiability when deciding which fragments to sample. In that incident, if a fragment was less than 5 square centimeters and unrecognizable, it was not tested for DNA (Roberts, personal communication). As a result, approximately half of the recovered remains were sampled. Similarly, investigators of the September 11 crash of United Airlines Flight 93 in Shanksville, Pennsylvania, an incident with a closed population, also decided that about one-third of the recovered remains were suitable for DNA sampling. Factors that may mitigate against sampling include types of remains known to be unsuitable for testing, such as fat, or the condition of remains, such as those that are calcined or soaked in jet fuel. The criteria for determining which remains are suitable for DNA testing will change over time as the science of DNA technology evolves.

WTC Remains Recovery

Human remains were recovered daily from both Ground Zero and the Staten Island landfill operations. Barges transported debris from Ground Zero to the landfill, where large pieces of building material were separated from the debris, which was spread out in open fields to be sorted. The dirt and other small bits were taken to sifters. In a process that is similar to screening the fill from an archaeological site, this material was shaken through industrial-size screens and sifters until the remaining material was carried onto a conveyor belt (Fig. 7.1). This belt was monitored by individuals who collected each item of human tissue or bone fragment (Warren et al. 2003). Each of these items was bagged separately and transported to the Medical Examiner's Office for processing and identification. This methodical sifting process allowed for individual remains collection, nearly eliminating incidents of

Fig. 7.1 Service members monitoring the conveyor belt for human remains at the Staten Island landfill operation
(*Source*: Rich Press, Copyright © 2001.)

recovery commingling at the landfill. However, the process of excavation, transport, screening, and sifting, along with decomposition, caused articulated elements to become disarticulated from each other. As a result, disparate pieces later had to be reassociated by DNA.

By contrast, the remains received from the disaster site were extremely commingled. Since Ground Zero accounted for most of the recovered remains, this commingling greatly complicated the triage process (MacKinnon and Mundorff 2006).

Commingling from the WTC disaster can be reduced to two primary types. This chapter will refer to Type 1 commingling as that involving remains collected together in one bag, but not attached by hard or soft tissue. Therefore, the commingling is recovery-induced. The potential for this type of commingling has long been recognized, and most recovery operations are equipped to cope with it. An experienced practitioner can easily detect Type 1 commingling by examining the remains to see which pieces are actually attached to each other. When the remains are not attached, the triage team disassociates them. However, another more severe and difficult to recognize type of commingling was also common in the WTC site. Type 2 commingling, which is disaster-induced, was caused by the extreme destructive and explosive nature of the building collapses. The explosive force that blew over fire trucks and peeled stone façades from buildings also disintegrated human bodies, turning bones into flying shrapnel, which became embedded in fragments of soft tissue from other individuals. The tidal wave of debris that carried human remains blocks away, depositing them on top of buildings, also fused soft tissue to bone fragments from multiple individuals so completely that the remains appeared to be from the same individual. This type of commingling is not as easily recognized as the commingling commonly seen in other disaster scenarios. Additionally, the sheer number of fragmented pieces of human remains—nearly 20,000—complicated efforts to resolve both types of commingling.

Site formation processes primarily determined the condition of the remains. These processes include the forces that initially formed the site, manipulation for excavation, as well as transformations over time including decomposition (Schiffer 1987). In the World Trade Center disaster, these initial processes included both primary and secondary events. The primary events that created this "archaeological site" included the impact of the two planes, the collapse of the South Tower, the collapse of the North Tower through the debris of the South Tower, and the subsequent destruction of five additional commercial buildings. Additionally, subterranean fires burned for 12 weeks, water was applied to those fires, and remains decomposed over the 8-month excavation (Fig. 7.2). Often, one or more of these factors are present at a disaster, but rarely, if ever, have they all occurred at one disaster site (Sledzik and Rodriguez 2002). These processes determined the shape and condition of the remains, in turn determining the methods used to process and identify them.

Secondary events also affected the composition of the remains and their condition upon arrival at the Medical Examiner's Office. The site consisted largely of 5,000-pound steel beams mixed with chunks of concrete making a "by hand" deconstruction impossible. Large machinery, including grapplers and cranes, was brought in to assist (Fig. 7.3). In order to place these cranes close enough to "the pile," it was first necessary to create platforms for them, which involved bulldozing and compacting sections of the site. Additionally, as the site was excavated below ground level, a ramp was built to allow excavation equipment to move in and out of "the pit." The material bulldozed for these constructions came from the pile itself and undoubtedly contained human remains. When these platforms and roads were later excavated, human remains were indeed recovered from this debris. This manipulation of decomposing and already fragmented human remains caused further destruction and commingling.

Fig. 7.2 Bucket of completely calcined remains recovered from one of the "hot spots" in Ground Zero that burned for 12 weeks
(*Source*: Office of Chief Medical Examiner, New York City.)

Fig. 7.3 Complicated excavation of Ground Zero showing heavy machinery used (*Source*: Unknown.)

The methods used in recovering individual remains further complicated the identification process and are also characterized as a secondary event. Excavations by untrained personnel and those performed in an unscientific manner affect the recovery process and may cause further commingling (Egana et al. 2005; Sledzik and Kontanis 2005; Tuller et al. 2005). The recovery and excavation of the human remains from Ground Zero was performed predominantly by Fire Department of the City of New York (FDNY) personnel. These individuals are not trained in techniques of forensic archaeology, excavation of human remains, identification or recognition of human remains (especially fragmented ones), or site formation processes. This lack of training complicated the recovery process and allowed for significant additional Type 1 (recovery-induced) commingling. Instead of consigning each piece of remains to a single bag, FDNY personnel filled body bags with potentially unrelated body parts before sending them on to the Medical Examiner's Office. FDNY also lacked knowledge and training on techniques for properly excavating a body found nearly intact yet buried within debris, especially those bodies in an advanced state of decomposition. Once decomposed, the smallest amount of movement or disturbance easily disassociates body parts. These issues can be mitigated with deeper knowledge of human anatomy and the application of forensic archaeological techniques (Blau and Skinner 2005; Skinner and Sterenberg 2005).

Intentional commingling at the site by the recovery personnel also complicated identifications. For instance, upon finding an empty monogrammed fire department bunker jacket during the excavations, FDNY personnel often placed the nearest human remains inside the jacket before transporting it to the Medical Examiner's Office. It seems that in placing these pieces in the bunker gear, FDNY hoped identifications would be accomplished faster and that families would receive "more"

of their loved ones because the remains were in a jacket with a name on it. Upon arrival at the mortuary, however, anthropologists immediately detected these reconstructions. Often, these reconstructions were quite obvious, as in leg bones placed in jacket sleeves. In another instance, examination of what appeared to be the nearly complete remains of a fireman fully clothed in bunker gear revealed two left feet, in boots neatly tucked into the bunker pants. The left foot tucked into the right pant leg was clearly not associated with this body yet had been grouped with it at the site during recovery. Although driven by understandable grief and the urge to identify their fallen, reconstruction activities at the site slowed the identification process, causing the triage team to more closely examine, and often separate into multiple cases, body parts found within clothing.

WTC Triage

A temporary mortuary specifically for WTC was set up in the receiving bay of the morgue, allowing regular autopsies to continue in the main autopsy suite. The WTC morgue was constructed to process a high-volume caseload. Two refrigerated tractor-trailer units were placed outside the mortuary, where the remains were held prior to triage, and eight tables were set up in the receiving bay. One table was designated for triage, six were staffed by medical examiners and their examination teams, while one held cases post-triage and awaiting examination. The identification process flowed like an assembly line, from triage to medical examiner to other stations including fingerprint, X-ray, dental, personal effects, and final storage.

Initially, forensic pathologists staffed the triage station. However, within days of the disaster, the management team determined that an anthropologist should direct triage. Two main considerations motivated this change. First, only medical examiners were allowed to fill in death certification forms, and it was important to free them to work the exam tables. Second, the remains were highly fragmented, with soft tissue obscuring obvious anatomic landmarks. This meant it would be advantageous for individuals with a deeper knowledge of osteological detail to identify the elements recovered. Additional factors, such as the substantial amount of nonhuman remains recovered from the destroyed restaurants, also made it advantageous for an anthropologist to direct triage.

The triage team consisted of an anthropologist and up to five assistants. The assistants varied in skills and expertise from OCME employees and medical students, to members of service from the Port Authority Police Department (PAPD), New York Police Department (NYPD), and Federal Bureau of Investigations (FBI) (Fig. 7.4). These law enforcement agencies were incorporated into the identification process both because of the criminal nature of the event as well as the significant number of members of service who had been lost. Their presence during triage allowed them to seize potential items of evidence, collected along with the remains.

Protocols and standards employed in the triage process changed drastically over the eight months of human remains recovery. Initially, the process was as follows:

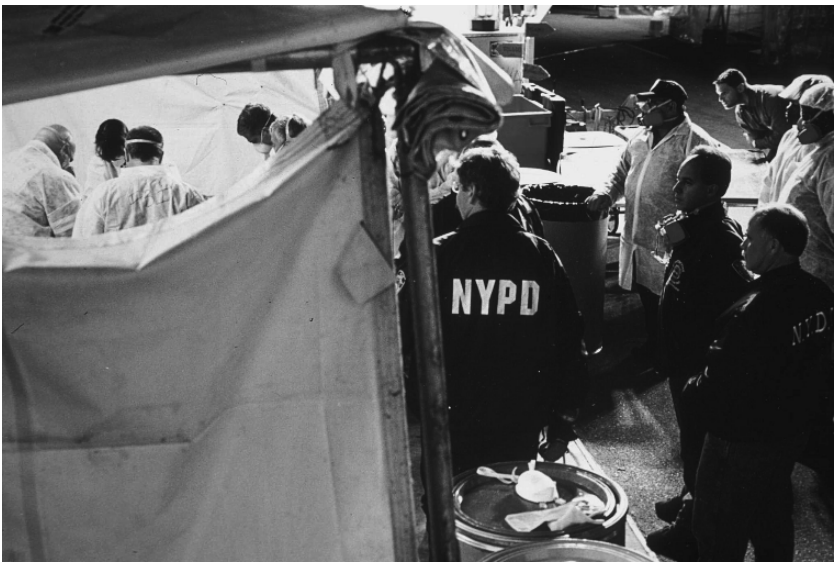

Fig. 7.4 View of the triage team in the OCME mortuary tent (*Source*: Rich Press, Copyright © 2001.)

A body bag was taken from the refrigerated truck outside the mortuary and brought to the triage table. Before opening a body bag, the triage team located a grid recovery tag, if there was one. After locating the tag, an anthropologist opened the bag and the contents were assessed. Bags from Ground Zero contained a wide variety of material, ranging from a single whole body to dozens of small red biohazard bags each filled with fragments of human remains. Additionally, building material, personal effects, and nonhuman remains were intermingled in these bags. The remains recovered from the Staten Island Landfill operation were bagged individually from the conveyor belt and, therefore, did not require an in-depth triage examination, other than to discard nonhuman remains.

Each bag was examined to eliminate unassociated and unattached parts within the body bag. Every piece of human remains that was not attached to another by hard or soft tissue was segregated. When such parts were found, they were removed individually, passed to an assistant, and placed in their own bag. Each of these bags became its own case. A case is a single set of human remains that is individually processed for identification and could be as small as a 1-inch bone fragment or as large as an entire body (Fig. 7.5). These new cases, created from the original single body bag they had been recovered with, were also labeled with the accompanying grid location attached to that original bag. These bags were then placed on another table to await medical examiner processing.

Within weeks, a coordination grid was established for Ground Zero, and recovery locations—usually written as a letter and number (e.g., K-10)—were recorded on tags attached to the body bags. If this grid number was attached to a bag, that

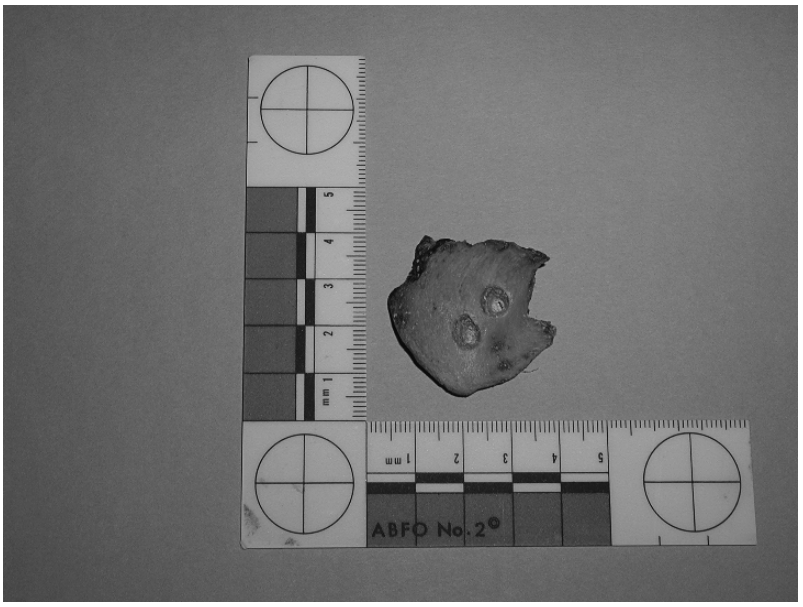

Fig. 7.5 Fragment of distal scapula; one of nearly 5,000 fragments from WTC that were approximately 1 inch or smaller. Note two drilled holes where DNA sample was removed (*Source*: Office of Chief Medical Examiner, New York City.)

locator followed all remains associated with that body bag. Although locator tags indicated from which 75-foot by 75-foot section of Ground Zero the human remains had been recovered, the accuracy and therefore usefulness of that information are uncertain. Depth was not accounted for and a fragment found on the surface of Grid K-12 as well as a fragment found at the bottom of the "pit" in Grid K-12 both received the same location designation, even though there may have been up to 140 feet of variance in depth between the two fragments. Additionally, bulldozing and road construction to assist excavations caused human remains to be moved and deposited outside their original grid location. Triage personnel invested substantial time and effort in transferring this grid locator to all of the bags that were subsequently split out of a single body bag from Ground Zero. Due to the unreliability of the information captured, it is questionable whether this was a good use of time and energy.

Medical Examiner personnel were initially caught off guard by the amount of destruction and fragmentation to the human remains. They simply possessed no theoretical schema to account for the injuries a human body endures in the collapse of a 110-story building. Compounding this, at the beginning of the disaster, the sense of urgency was intense and triage was sometimes bypassed altogether to speed bodies through identification. (Larger body parts that initially bypassed triage in favor of quick identification generally possessed standard identifiers such as fingerprints or dental.) However, within weeks, Medical Examiner personnel came to appreciate

the true force of the disaster and the extreme commingling. Because of this, investigators came to believe that small bone fragments were likely embedded in the tissue of body parts that had bypassed triage and that some cases of commingling might have initially gone undetected. The policy of testing each piece of remains made it imperative to retrieve these small fragments, and a secondary review of all of the remains was undertaken by a group of anthropologists. This process, known as the Anthropological Verification Protocol (AVP), detected and corrected instances of commingling that were missed in the initial investigation (Budimlija et al. 2003; MacKinnon and Mundorff 2006). Of the nearly 17,000 cases reexamined, fewer than 100 were found to be commingled, and these were subsequently split into approximately 300 new cases.

In addition to implementing the AVP project, the triage process was strengthened to account for the extensive Type 2 (disaster-induced) commingling. Sorting out this type of commingling is much more complicated than looking for separate pieces within a single body bag. Often pieces of muscle and bone from different individuals can become fused together, mimicking the appearance of a contiguous piece (Rodriguez 2005). During triage it was not uncommon to find skull fragments of one individual deep within another individual's thigh muscle, and rib fragments were frequently found embedded in other body parts. It became clear that bone fragments of multiple individuals could be commingled together into one large tissue mass. Even cases that appeared to be independent body parts frequently had dozens of small bone fragments embedded throughout. This type of commingling also has the potential to bias DNA analysis if the sample taken from the remains inadvertently includes a fragment from a different individual. For this reason, the anthropologist conducting the triage process began sorting out even the smallest fragments of human remains.

Every fragment of bone and tissue was removed and placed in its own bag for individual processing. It was not uncommon for anthropologists to reduce a body bag recovered from Ground Zero into as many as 100 new cases. When the anthropologist believed, based on morphological characteristics, that numerous unattached fragments within a body bag likely belonged to one individual, the new cases triaged out of that bag were grouped together for a single medical examiner to process consecutively and cross-reference. For example, a body bag might contain multiple ribs, all appearing to originate from the same individual—with no overlap in rib number or side—yet unattached by soft tissue because of decomposition. Even if it was thought these all belonged to the same individual, these ribs were not treated as one case and instead each rib was bagged as an individual case. However, all of those case bags were placed into one bin so a single medical examiner could process them consecutively (Fig. 7.6). Upon receiving a grouping of individually bagged remains, thought to be from the same victim, the medical examiner noted a case number cross-reference in the case file of each fragment examined. This notation indicated that, although these were separate case numbers, the anthropologist believed they might belong to the same individual. This information was useful later when some cases that were cross-referenced to each other were identified to the same individual, but other cross-referenced fragments were not. Because there was additional

Fig. 7.6 Separate bins of individually bagged remains that will be cross-referenced to each other as groups
(*Source*: Rich Press, Copyright © 2001.)

evidence of association, these fragments could be further targeted for identification. Years later, it appears that many of the cases that were cross-referenced to a primary case have indeed been linked by DNA to that same primary case.

Each of the World Trade Center disaster's individual characteristics shaped the triage protocols established in the mortuary. The number of victims, the number of recovered remains and their degree of fragmentation, and the condition of the remains were all influencing factors. Additionally, the recovery duration, the relative lack of expertise of the recovery personnel, and the recovery techniques demanded a complicated and exacting triage.

Crash of American Airlines Flight 587

The crash of Flight 587 is notable for the relative speed—only 28 days—with which the victims were identified. It is worth noting the factors leading to this rapid identification, especially as contrasted with the lengthy identification process of the World Trade Center disaster. First, this mass fatality incident involved a closed population, meaning a manifest existed documenting each victim's name. (In addition, local residents provided information for those killed on the ground.) This allowed the Medical Examiner's Office to begin collecting antemortem information and facilitated rapid fingerprint and dental identifications. By comparison, it took years to finalize the total number and names of missing persons for the World Trade Center disaster. Second, the remains' size and condition made them easier to identify. Many of the remains from Flight 587 were large enough to autopsy and quickly identify, meaning that some part of the body retained an identification modality that allowed for rapid identification, such as fingerprints or dental. By comparison, the remains

from WTC were fragmented into such small pieces (over 5,000 of which were no larger than an inch) that other means of identification were not available, forcing a lengthy DNA identification process. Third, the WTC disaster involved nearly 10 times as many fragments as Flight 587. Finally, because the crash followed closely on the heels of the WTC disaster, the Office of Chief Medical Examiner was already set up to process a major incident.

Victim remains began arriving at the mortuary by late afternoon the day of the crash. Since the cause of the crash was initially unknown, all of the bodies were autopsied. This allowed the FBI to collect evidence to determine if the crash was caused by terrorism and allowed for toxicological testing on the pilot, co-pilot, and passengers. Autopsies were preformed when approximately half of the body was present; of the nearly 2,100 human remains recovered, 305 warranted autopsies. In addition to the fragmentation from impact forces, jet fuel-fed fires caused extensive charring and most of the victims were burned and unrecognizable. However, in contrast to WTC, the Flight 587 fragments were large enough that most were anatomically identifiable. Therefore, identifications relied heavily on fingerprint, dental, and personal effects.

The remains were transported to the Medical Examiner's Office and placed into a refrigerated truck outside the temporary morgue previously constructed to process the World Trade Center remains. Although the same facility was used to triage and process the fragments from Flight 587, the bodies were autopsied in the main autopsy room. The remains were recovered from the crash site in two types of bags. The large body parts—torsos and bodies—were collected in body bags while the fragments were collected in smaller red plastic biohazard bags. Each bag was unloaded individually and brought to the triage station. The triage team consisted of an anthropologist and up to five assistants. The assistants were again personnel from the FBI, PAPD, and NYPD already present at the OCME working on the WTC remains. The anthropologist opened each bag to sort through the contents. Unlike WTC, there were many relatively whole bodies and large body parts with little decomposition. The bodies were given priority over the fragments since they were to be autopsied and were likely to be identified quickly.

Responding to the insight gained from processing the WTC disaster, the OCME had established a strict triage protocol by the time Flight 587 went down. However, this protocol was flexible, allowing modification according to a disaster's characteristics. The Flight 587 triage process was as follows: A single body bag was brought to the triage team and opened. An examination of the remains was performed to determine that everything associated with the body was indeed physically attached by hard or soft tissue. At the crash site, isolated fragments of human remains such as skull fragments, amputated hands and feet, and pieces of fat and soft tissue had been collected along with bodies and grouped into the same recovery body bag (Type 1 recovery-imposed commingling). These additional fragments were removed from the original body bag and placed in their own bags to await processing. If a body bag contained a body lacking a foot due to traumatic amputation and if a foot was also found in the bag, these two items did not automatically remain together. However, if tissue or skin held the remains together, or if the fractured bones conjoined with

each other, then the two pieces were kept together. If this standard was not met, the smaller fragment was removed from the body bag, placed into its own bag, and processed with the other fragments after the autopsies were completed.

As compared with WTC, commingling in the Flight 587 remains was easier to recognize and generally resulted from recovery techniques and not the Type 2 explosive commingling discussed above. However, like WTC, rescuers collected multiple unassociated body parts and placed them in the same bag. Type 1 recovery-induced commingling is comparably easy to discern and mitigate during the triage process by separating out unattached and unarticulatable remains. But, unlike WTC, very few nonhuman remains were recovered from the Flight 587 crash site. When it was determined at the triage station that only a single body or body part remained in a body bag, it was zipped shut, the word "triaged" was written on top (Fig. 7.7), and a file containing a case number and all of the paperwork was assigned to the body. A red folder (to differentiate them from the neutral-colored ones used for WTC) in a plastic cover was attached to the top of the body bag, to accompany that body through all of the identification processing stations. As with the World Trade Center, the body part and its corresponding paperwork were then taken through all of the other stations by an escort, usually a member of service. Depending on which part of the body was present, station stops might include X-ray, dental, and fingerprint, all followed by the autopsy.

Fig. 7.7 Triage team during Flight 587
(*Source*: Rich Press, Copyright © 2001.)

Once all of the large body bags had been triaged, allowing the autopsies to proceed, the small bags of fragments were triaged under the same protocols. Each bag was opened individually and examined by the anthropologist. Bags containing only a single fragment were closed and placed on the next table to await processing. If the bag being triaged contained multiple fragments, each piece was isolated and placed into its own bag, sealed, and then placed on the next table to await examination and further processing. Dozens of new bags could be created from the contents of a single recovery bag. The anthropologist was empowered to evaluate the fragments for possible reassociation with other fragments within the same recovery bag. However, reassociation of fragments from disparate recovery bags required verification by dental, fingerprint, DNA, or some other means. Since the fragments were processed after the bodies had been autopsied, no attempts were made to physically reassociate fragments to bodies. This would have been logistically impossible, since many of the bodies were identified and released before the fragments were processed. Reassociation of fragmented remains in the Flight 587 and WTC disasters relied primarily on DNA. These reassociation methods differed for the Staten Island Ferry Crash, which will be discussed below.

The autopsies were completed in 7 days, and the approximately 1,800 unassociated fragments were processed in 12 days. Procedures for examination and documentation of these fragments followed protocols developed for WTC, and, as with the WTC disaster, every recovered fragment was sampled for DNA. This is unusual for a plane crash or an incident with a closed population where 100% victim identification can be achieved without testing every fragment. Following triage, each bag was reopened individually and each fragment was assigned its own sequential case number. All of the information relevant to that fragment was documented in the file, including injury patterns, personal effects, a detailed description of the remains, and information about which other stations the fragment visited. For instance, an amputated hand would go to the fingerprint station but not the dental station. The DNA sample was taken during the examination, which enabled the piece to be identified and reassociated to a body if other modalities of identification were lacking, such as dental or fingerprint.

As with every mass disaster, recovery techniques affect how medical personnel process and identify victim remains. This is especially true with fragmented human remains because of the heightened potential for commingling or contamination. As seen with the WTC disaster, the techniques employed in recovering remains increased commingling, which in turn required a very strict triage process, even to the extent of separating remains found within clothing. Remains recovered from Flight 587 endured less Type 1 (recovery-induced) and significantly less Type 2 (disaster-induced) commingling than the remains from the World Trade Center disaster. Additionally, the number of victims, recovery techniques, and characteristics of the site were drastically different and therefore the protocols for triage were modified. The nature of this disaster meant that measures such as cross-referencing and grid locators were not utilized. However, with well-coordinated recovery methods and fewer victims and fragments, the tasks performed during triage again are

modified. The crash of the Staten Island Ferry will be the next disaster discussed and will illustrate these differences.

The Staten Island Ferry Crash

The *Andrew J. Barberi* crashed into a concrete maintenance pier south of the docking point at the Staten Island Ferry terminal, which sliced through the front of the vessel (NTSB 2005). Ten people were killed instantly, and one more died later from medical complications. In addition, 70 passengers suffered severe injuries including amputated limbs (NTSB 2005). The vessel's primary impact area was the midship section on the main deck of the New Jersey side. However, as the allision continued, the concrete pier also passed through the passenger cabin. "All of the fatally injured passengers were found on the New Jersey side of the vessel's main deck" (NTSB 2005).

The Staten Island Ferry crash involved relatively few victims and would not normally stress an agency as large as the New York City Medical Examiner's Office. However, several circumstances conspired to dictate that this should be designated as a mass fatality. First, the accident occurred in a public transit area, which meant there was no initial manifest of the victims, making this an open population. Second, because so many of the victims were reasonably identifiable, public and local officials expected speedy identification (Brondolo 2004; NTSB 2005). Third, the ensuing publicity resulted in thousands of inquiries from possible victim families, stressing OCME's internal systems. Finally, a significant number of amputated body parts and unassociated bone and tissue fragments were recovered from the boat and the water. Along with the 10 bodies, approximately 33 bags in total were removed from the site and transported to the Manhattan Office of Chief Medical Examiner. Taken together, these circumstances mitigated in favor of designating this incident as a mass fatality.

Emergency personnel were dispatched to the accident scene within minutes of the event. These included over 300 personnel from New York Police Department (NYPD), 200 from the Fire Department (FDNY), 60 Emergency Medical Service (EMS), 6 Coast Guard vessels, the Army Corps of Engineers, and other rescue and support units. This response even included dive teams, for individuals who might have fallen into the water (NTSB 2005). Along with this massive response, medicolegal investigators (MLIs) from the Medical Examiner's Office arrived on scene to assess the casualties and participate in victim recovery. Following the 9/11 events, OCME MLIs had been working hand in hand with the FDNY and NYPD to streamline the response to mass fatality incidents, and this extensive multi-agency training and communication helped ensure an efficient recovery and identification of the deceased victims.

Emergency personnel recovered several fatalities from the main deck, moving them before the Medical Examiner's team arrived. The rest of the bodies and body parts were recovered over the next few hours by emergency personnel under the guidance of the medicolegal investigators. MLI guidance helped limit the number

of fragments placed into a single recovery bag (Type 1 commingling). This reduced commingling and contamination and ensured proper labeling of the recovery location for each individual remain. Even when found in close proximity, fragments that were not physically attached were placed in separate bags. However, this did not negate the need to stringently triage all remains when they reached the mortuary. It is impossible to accurately assess commingling at a disaster site, especially Type 2, or disaster-imposed commingling, which is often deeply embedded into tissue masses and difficult to see. Upon further examination in the mortuary, especially with radiography, fragments thought by recovery personnel at the scene to be intact, comprising only one individual, have been shown to be commingled (Viner et al. 2006).

The victim's bodies and recovered body parts began arriving at the Manhattan mortuary early in the evening on the day of the accident. Because the victims were mostly recognizable (9 of the 10 bodies), the Chief Medical Examiner decided to have the medical examiners perform a preliminary analysis of the victims, that evening, for identification purposes only. The complete autopsy and examination of the bodies and associated fragments took place the following morning.

The following morning, the victims were laid out in the autopsy room, most suffering serious blunt force injuries, traumatically amputated limbs, eviscerated torsos, and massive head trauma. In addition to the 10 bodies receiving autopsies, bags of unassociated body parts including amputated limbs, organs, skull fragments, and pieces of fat and soft tissue were also brought into the autopsy room. Unlike WTC and Flight 587, there were no explosive forces involved with this disaster, minimizing the fragmentation and associated commingling, and limiting the commingling to Type 1. And, as mentioned above, the MLIs' presence at the scene helped ensure that proper recovery techniques were utilized, significantly reducing this commingling as well. As compared with Flight 587 and WTC, the triage process for the Staten Island Ferry crash was less concerned with sorting out commingled remains, focusing on reassociating fragments to nearly complete bodies.

In this incident, the triage team consisted of an anthropologist and an assistant with significant experience in mass fatality work and knowledge of human anatomy. As opposed to WTC and the crash of Flight 587, the triage and autopsy processes were closely integrated and the triage team worked directly with the medical examiners in a concerted effort to reassociate fragments with bodies during autopsy. The limited number of victims and fragments meant that quick reassociation to the bodies was often possible. As autopsies were being conducted, the triage team opened the recovered bags one by one, according to the OCME triage protocol. An initial sort was performed to isolate all of the individual fragments. As before, anything not attached to another fragment by hard or soft tissue was isolated as its own case. However, these cases were not rebagged as in the previous disasters discussed, but instead were laid out on a gurney. At this point, the anthropologist anatomically evaluated all of the displayed body parts and fragments.

Concurrently, the medical examiners conducting the autopsies evaluated the bodies for missing parts. With this information, attempts were made to reassociate isolated body parts with those bodies missing a correlative part.

Many of these reassociations were simple. For instance, an isolated hand could be matched with a body that was missing a hand. For the association to be acceptable, the bones must conclusively conjoin at the fracture site. An exception to this rule would be when process of elimination is valid (Adams and Byrd 2006). When this standard was met, the isolated body part was not given its own case number, but instead was included in the autopsy case number assigned to the body and the separation was noted along with the other injuries documented in the autopsy notes. In another case, a fragment of liver was reassociated to a body that suffered a partial liver avulsion. This is rare, but in some instances it is appropriate to rearticulate soft tissue.

Other cases were more complicated. For instance, multiple skull fragments were recovered from the accident scene. Many of these fragments articulated to each other and were grouped together as a single case. However, because so many of the bodies being autopsied suffered skull trauma, reassociation of skull fragments to a body was quite difficult. Although some skull fragments were reassociated, others could not be assigned to any particular individual. In these instances, each isolated fragment became its own case. Fragments, such as pieces of fat or muscle, that could not be reassociated to any one individual were also assigned their own case number and treated as individual cases. Reassociations during autopsy accelerated the process of identification for unassociated fragments by creating fewer cases, resulting in less DNA testing. In addition, immediately reassociating fragments with bodies during autopsy reduced the likelihood of further parts being identified to that individual weeks or months later. As the above discussion demonstrates, reassociation during the triage process for the Staten Island Ferry crash differed from WTC and Flight 587, where reassociation during triage was only attempted for fragments found within an individual recovery bag.

The paperwork completed for each unassociated fragment was similar to the other disasters discussed. It consisted of a detailed anatomic description of the remains, which other fragments were found in association with that piece, and the location of recovery, if documented on the original recovery bag. Like WTC and Flight 587, a DNA sample was removed from every unassociated fragment, placed in a 50-mL tube, labeled with the same case number, and submitted to the Department of Forensic Biology for analysis. After sampling, the remaining fragment was rebagged, labeled with the case number, and stored within a refrigerated unit until it was identified. A DNA sample was also taken from each body during autopsy, enabling these unassociated fragments of bone and tissue to be identified and reassociated with the correct body.

With little Type 1 (recovery-induced) commingling, and no Type 2 commingling, the triage process for the Staten Island Ferry crash differed significantly from the WTC and Flight 587 disasters. Additional characteristics such as a small victim-to-fragment ratio, little decomposition, and a controlled surface recovery also shaped this triage process. As compared to the other two disasters, the triage process for the Staten Island Ferry crash was still quite valuable but involved more reassociation of fragments to bodies than sorting out commingled remains.

Conclusion

Identifying victims from mass fatality events can be a long and complicated process. Many components including recovery, numbering, mortuary processes, death certification, and antemortem information collection affect the overall success rates. Other important factors affecting the identification process include the number of victims, the degree of fragmentation, the length of the recovery operation, and whether or not it is an open or closed population. This chapter discussed one aspect of the mortuary process, triage, and its interplay with the other aspects of the process of identifying fragmented remains from three distinct mass fatality events in New York City (WTC, Flight 587, and the Staten Island Ferry). Each event differed in the degree of fragmentation, recovery duration, and the number and population characteristics of victims, all of which was reflected in the triage process. Additionally, the methods used to recover the remains varied greatly between the different events, which also shaped triage. Although the lengthy WTC recovery could not have been avoided, changing certain recovery practices could have helped in reducing needless commingling created at the site. This was highlighted by the Staten Island Ferry crash, where Medical Examiner personnel were not only present but were active participants in the organization of the recovery of human remains, greatly reducing commingling. This chapter illustrates the value of using personnel trained in recovering human remains. However, political, social, and cultural factors oftentimes place these decisions beyond the jurisdiction of medicolegal professional, who must be able to adapt and contend with the condition of the remains as they are received.

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