Terrorist Bombings

Lessons Learned From Belfast to Beirut

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Experience in the management of mass casualties following a disaster is relatively sparse. The terrorist bombing serves as a timely and effective model for the analysis of patterns of injury and mortality and the determination of the factors influencing casualty survival in the wake of certain forms of disaster. For this purpose, a review of the published experience with terrorist bombings was carried out, providing a study population of 3357 casualties from 220 incidents worldwide. There were 2934 immediate survivors of these incidents (87%), of whom 881 (30%) were hospitalized. Forty deaths ultimately occurred among these survivors (1.4%), 39 of whom were among those hospitalized (4.4%). Injury severity was determined from available data for 1339 surviving casualties, 251 of whom were critically injured (18.7%). Of this population evaluable for injury severity, there were 31 late deaths, all of which occurred among those critically injured, accounting for an overall "critical mortality" rate of 12.4%. Overall triage efficiency was characterized by a mean overtriage rate (noncritically injured among those hospitalized or evacuated) of 59%, and a mean undertriage rate (critically injured among those not hospitalized or evacuated) of .05%. Multiple linear regression analysis of all major bombing incidents demonstrated a direct linear relationship between overtriage and critical mortality (r^2 = .845), and an inversely proportional relationship between triage discrimination and critical mortality (r^2 = 0.855). Although head injuries predominated in both immediate (71%) and late (52%) fatalities, injury to the abdomen carried the highest specific mortality rate (19%) of any single body system injury among immediate survivors. These data clearly document the importance of accurate triage as a survival determinant for critically injured casualties of these disasters. Furthermore, the data suggest that explosive force, time interval from injury to treatment, and anatomic site of injury are all factors that correlated with the ultimate outcome of terrorist bombing victims. Critical analysis of past disasters should allow for sufficient preparation so as to minimize casualty mortality in the future.

TERRORISM IS THE UNLAWFUL EXERCISE of random and ruthless violence against property or individuals, usually innocent civilians, in order to intimidate governments or societies for political or ideological purposes.[1,2] The increasing frequency of terrorist acts occurring on a worldwide scale has served to focus attention on the problems that confront those medical personnel and facilities called upon to organize and provide treatment for the victims. The medical response to terrorist disasters has, logically enough, developed to the most efficient and sophisticated degree in those countries which have been most commonly exposed to these events.[3-5] This medical experience can serve as a valuable lesson to countries such as the United States in which such experience is sparse, but in which the potential for terrorist activity is on the rise.[2]

The bomb explosion is a particularly devastating and increasingly common form of terrorist violence. Successful management of this unique trauma requires an understanding of its natural history and epidemiology. A review of the published experience with terrorist bombings is presented for this purpose. A critical analysis of these data in the light of current knowledge of the biodynamics of explosive injury should allow identification of the patterns of injury and mortality, and of the factors that correlate with optimal survival of casualties.

Clinical Material

A review of 14 published studies of terrorist bombing incidents that occurred between 1969 and 1983 provided a combined population of 3357 documented casualties for analysis of injury and mortality patterns (Fig. 1). The specific circumstances of these incidents were quite variable and thus warrant a brief overview.

On October 23, 1983, a four-story building at Beirut International Airport in Lebanon, which housed approx-

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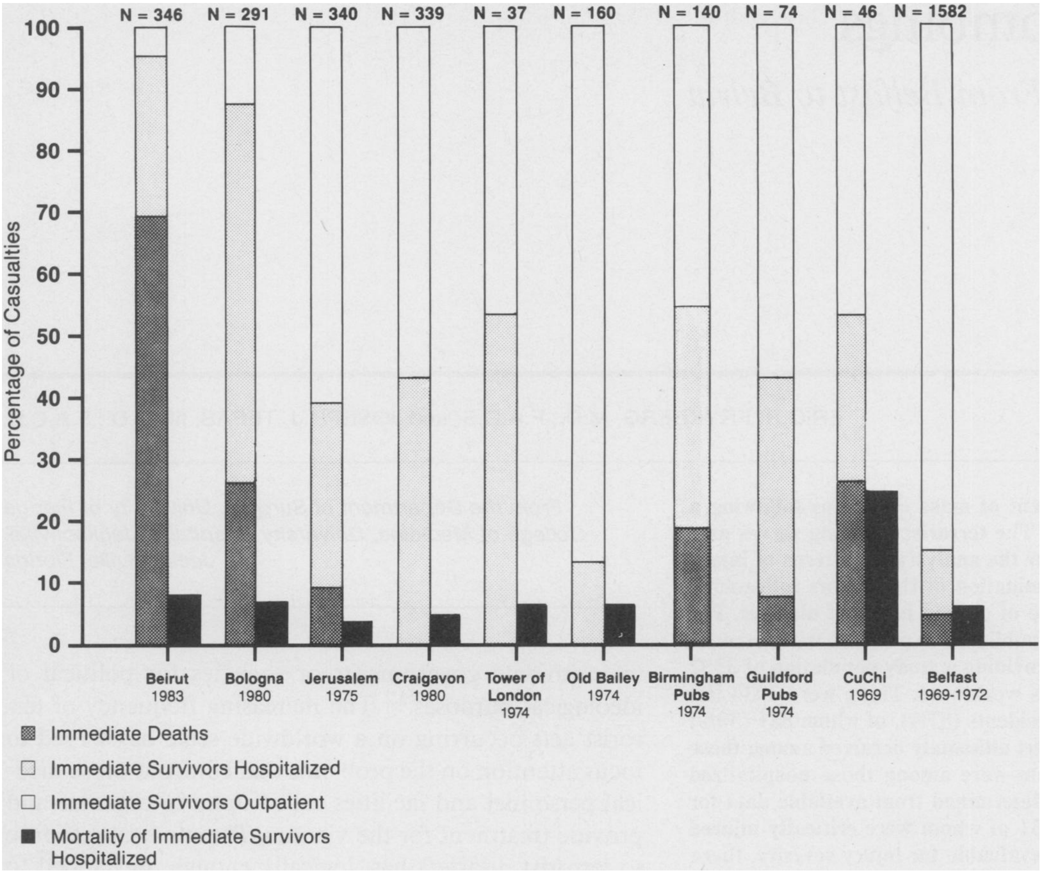

FIG. 1. Graphic depiction of casualty outcome after terrorist bombing incidents.

imately 350 U.S. Marines, was demolished in a suicide truck-bombing attack that delivered the explosive equivalent of 5455 kg of TNT.[6-10] This explosion resulted in 346 casualties, 234 of whom (68%) were immediately killed. Of the 112 immediate survivors, seven late deaths (6.3%) ultimately occurred. The majority of survivors (86%) were evacuated by air ambulances for definitive care after triage and resuscitation aboard a U.S. Navy ship that was at the scene.

In August 1980, a bomb was detonated in the main railroad terminal in Bologna, Italy, with an estimated explosive force of 20 kg of TNT.[11] Two hundred ninety-one casualties resulted, 73 of which were immediate deaths (25%); 181 of the 218 immediate survivors (83%) were admitted to the hospital. There were eleven deaths in this latter group (6%).

A series of 24 terrorist bombings were documented over a 4-year period in Jerusalem, Israel.[5,12] These resulted in the hospitalization of 96 of the 314 surviving victims, three of whom eventually died.

Reports of 339 casualties of 77 bombings that occurred in Craigavon, Northern Ireland between 1972 and 1980,[13] and of 1582 casualties of 110 bombings that took place in Belfast, Northern Ireland from 1969 to 1972[3,14,15] document similar patterns of predominantly noncritical injuries in hospitalized survivors with low mortality rates.

In 1973 and 1974, there were six terrorist bombings in Great Britain that were extensively analyzed in several reports.[15,16] A car bomb with the explosive equivalent of 80 kg of TNT was detonated outside the Old Bailey in London on February 6, 1973. This explosion resulted in 160 injured victims, 19 of whom were hospitalized. One outpatient survivor died of a myocardial infarction.[17] In July 1974, a bomb containing 4.5 kg of TNT exploded within an armory in the Tower of London, causing 37 injuries. Of the 19 hospitalized survivors one death occurred.[18] Explosions occurred in two crowded pubs in Guildford, England in October 1974, killing five people and injuring 64, with 24 casualties requiring hospitalization.[16] Similar bombings occurred in November 1974 in two pubs in Birmingham, England, resulting in 119 casualties, 42 hospital admissions, and 21 deaths.[16,19]

The final terrorist incident contributing to this review occurred in January 1969 in a U.S. military mess hall in Cu Chi, Vietnam. An explosion of 10 kg of TNT was detonated during the noon meal, resulting in 46 total casualties. There were twelve immediate deaths (26%), and twelve survivors were evacuated to U.S. Army hospitals for definitive care. Three deaths occurred in this latter group, two of which involved untreated casualties with expectant injuries.[20]

Results

These 220 terrorist bombing incidents resulted in an average of 15.3 casualties per incident (range of 4.5–346). There were 423 casualties who died before reaching medical care (12.6%), and only 881 (30%) of the 2934 immediate survivors were hospitalized. The ultimate mortality rate of all immediate survivors was 1.4% (40 deaths), and the mortality which eventually occurred among hospitalized survivors was 4.4% (39 deaths).

Operations were performed on 812 casualties. Soft tissue and bone injuries accounted for 84.5% of all operations performed (Table 1).

An analysis was made of the incidence and mortality of specific body system injuries of this combined population of 3357 terrorist bombing victims (Table 2). Although soft tissue and bony extremity injuries predominated among survivors, they did not apparently contribute to mortality, with the exception of traumatic amputations. These latter injuries were associated with 10% of the deaths in the immediate survivor group. Head injury was the most common contributor to both immediate fatality and late fatality, contributing to 71.4% and 52% of immediate and late fatalities, respectively, yet only 1.5% of all survivors with head injury ultimately died. Injuries to the abdomen and the chest carried the highest probability of late deaths among those immediate survivors in which they occurred (19% and 15%, respectively). Pulmonary blast injury was the most common form of thoracic trauma found in immediate fatalities, and although it was rare among surviving casualties, this specific injury still accounted for 11% of the overall mortality rate when it occurred in immediate survivors (Fig. 2).

An assessment of the injury severity of 1339 of the surviving casualties on whom sufficient data was available[5,10,11,13,16–20] revealed that 251 (18.7%) were critically injured (Table 3). The proportion of critically injured survivors of individual incidents ranged from 7.6% to 34%. Determination of injury severity was facilitated in three series[5,10,11] by the application of the Injury Severity Score (ISS).[21] Of this population, 610 casualties (45.5%) were admitted to a hospital, and all 251 critically injured casualties were in this group. The rate of overtriage, or the proportion of noncritically injured survivors hospitalized for immediate care,[22,23] was thus 59% overall and ranged from 8.3% to 80% (Table 3). There was one case that could conceivably be considered undertriage—that of a death due to acute myocardial infarction that occurred in a victim of the Old Bailey bombing shortly after his discharge from the emergency department.[17] Of the 2053 nonhospitalized survivors of this review this was the only death or complication documented (.05%). Of the 1339 immediate survivors evaluable for injury severity, 31 died, accounting for an overall mortality rate of 2.3% in this

TABLE 1. *Surgical Procedures Performed on 812 Survivors of Terrorist Bombings*

Surgery	No. of Casualties (%)
Soft Tissue	543 (67.0)
Bone	142 (17.5)
Abdomen	45 (5.5)
Head	17 (2.0)
Miscellaneous (chest, ear, vascular, eye, neck, spinal cord, nerve)	65 (8.0)

TABLE 2. *Relation of Specific Injury to Casualty Mortality in 3357 Victims of Terrorist Bombings*

	Incidence in Immediate Fatalities		Incidence in Immediate Survivors (n = 2934)		Mortality of Specific Injuries*		Percentage of Deaths of Immediate Survivors (n = 40)
Specific Injury	No.	%	No.	%	No.	%	with Specific Injury
Head	167†	71.4†	920	31.4	14	1.5	52.0‡
Chest	—	25.0§	53‖	2.0	8	15.1	21.0¶
Blast lung	—	47.0§	18	0.6	1**	11.0	3.7‡
Abdomen	—	26.0–34.0§	42	1.4	8	19.0	21.0¶
Burns	—	—	146	5.0	4	2.7	10.0
Traumatic amputation	—	—	36	1.2	4	11.0	10.0
Bony extremity	—	—	320	10.9	0	0	—
Soft Tissue	—	—	1624	55.4	0	0	—

* Deaths of immediate survivors with injury/Total survivors with injury.
† Data from 234 fatalities in Beirut disaster.[7]
‡ Only 27 deaths evaluable.
§ Data from 305 fatalities in Northern Ireland.[15,16]
‖ Only 2620 survivors evaluable.
¶ Only 38 deaths evaluable.
** Only 9 blast injuries evaluable.

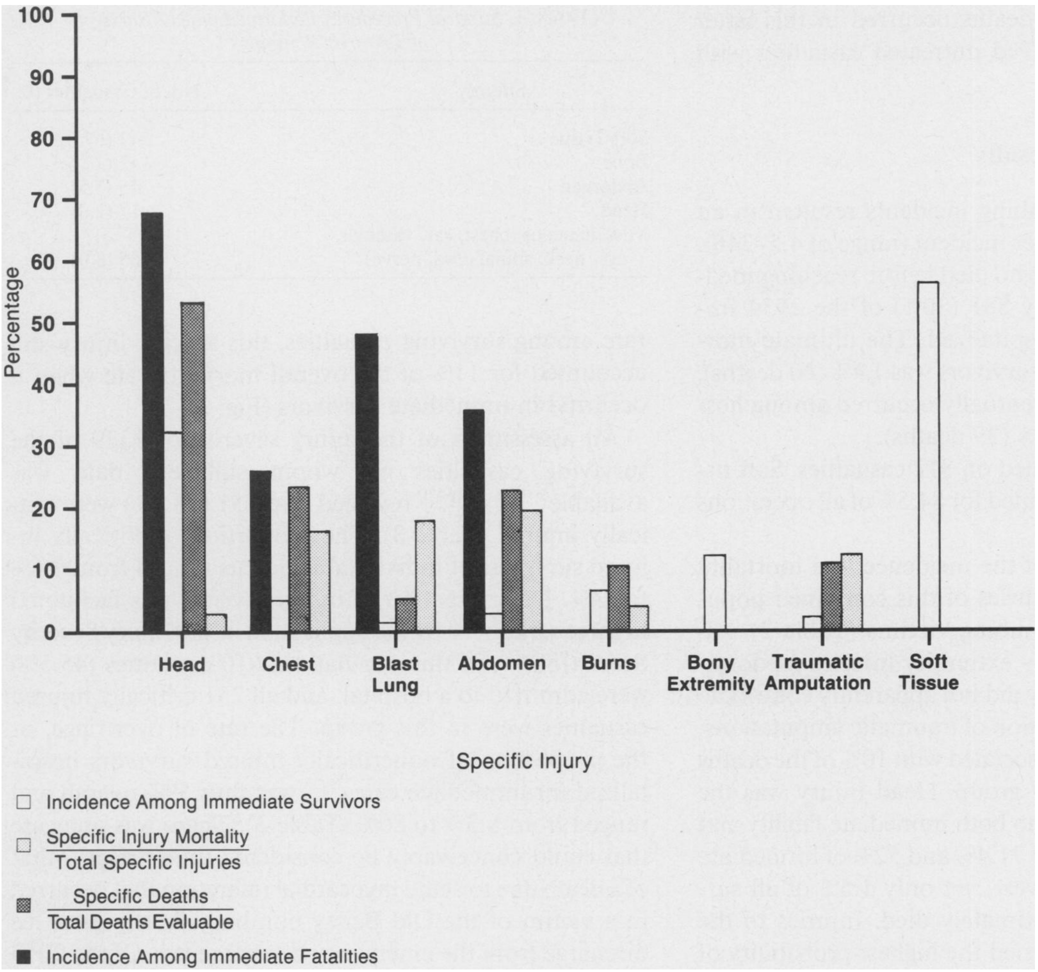

FIG. 2. Collective profile of injury patterns among 3357 terrorist bombing victims.

population. Because all deaths were judged to have occurred among the critically injured population, a "critical mortality" rate of 12.4% was thus derived (Table 3).

This information was used to determine the relationship between the efficiency of triage and the mortality rate of triaged casualties. Only those nine terrorist bombing incidents involving a large number of casualties delivered simultaneously to a hospital were applied to this relationship,[10,11,16–20] in order to accurately evaluate the specific influence of triage on casualty survival. A direct linear relationship was found between the degree of overtriage in these events and the critical mortality rate (Fig. 3). Triage discrimination, or the extent to which overtriage was avoided by separating casualties with noncritical injuries from those who were hospitalized, was found to be inversely proportional to critical mortality (Fig. 4).

Discussion

Every disaster involves a unique set of circumstances in terms of etiology, environment, casualty load and available medical resources. This review indicates that several broad principles can nevertheless be applied to the planning and execution of medical care for terrorist bombing victims and may contribute to maximal casualty survival.

Planning

The advance formulation and rehearsal of a disaster plan is the first essential element in the successful management of the victims, since these incidents are unpredictable in their timing and location, and typically result in large numbers of casualties with distinct patterns and complexity of injuries.[3,10,13,14,17,24–27] Such a plan should involve the immediate availability of surgeons who are trained and experienced in the principles of mass casualty triage and the treatment of the multiply-injured victim. Protocols for record-keeping are a very important part of the planning effort. All victims must be identified and tracked through the various levels of care that disaster management involves. This not only assures the continuity of care necessary for optimal medical management of each victim, but also allows the retrospective assessment of casualty injuries and treatment, which may ultimately contribute to improving survival in future disasters.[8–10,21,24]

TABLE 3. *Injury Severity, Overtriage, and Critical Mortality of 1339 Evaluable Survivors of Terrorist Bombings*

Location of Incident	Critically Injured Survivors (%)	Overtriage in Hospitalized Survivors (%)*	Late Deaths	Percentage Critical Mortality†
Beirut	19 (17.0)	77 (80.0)	7	37
Bologna	48 (22.0)	133 (73.5)	11	23
Jerusalem	23 (8.5)	73 (76.0)	3	13
Craigavon	113 (33.0)	29 (20.4)	5	4
Tower of London	10 (27.0)	9 (47.4)	1	10
Old Bailey	4 (2.5)	15 (79.0)	1	25
Birmingham	9 (7.6)	12 (57.0)	2	22
Guildford	22 (34.0)	2 (8.3)	0	0
Cu Chi	3 (8.8)	9 (75.0)	1	33
TOTAL	251 (18.7)	359 (59)	31	12.4

* Hospitalized survivors with noncritical injuries (percentage of total hospitalized survivors).

† Number of deaths among critically injured / Number critically injured survivors

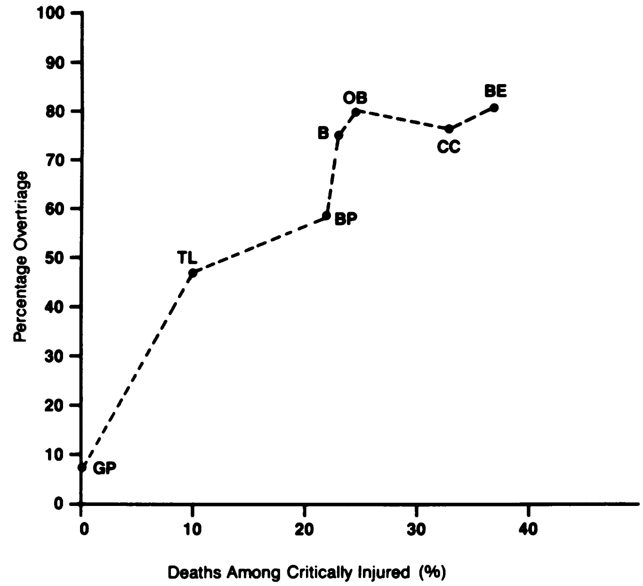

FIG. 3. Relationship between overtriage rate and mortality of critically injured victims after nine terrorist bombing incidents involving the immediate delivery of large casualty loads. Multiple linear regression analysis shows $r^2 = 0.845$. GP = Guildford Pubs, TL = Tower of London, BP = Birmingham pubs, B = Bologna, OB = Old Bailey, CC = Cu Chi, BE = Beirut.

Biology of Explosive Injury

The pathophysiology of explosive injury has been extensively studied since the 18th century author Pierre Jars first correctly delineated the mechanism of death as "la grande et prompt dilation d'air."[15] This mechanism is now considered the "primary blast effect," involving a sudden increase in air pressure that is propagated radially from the explosion at the speed of sound or greater. The degree of damage resulting from the blast wave depends upon the magnitude and duration of the peak overpressure, which, in turn, depends upon the explosive force and the environment in which the explosion occurs.[15,16,28,29] Indoor detonations tend to be associated with especially severe blast injuries because of a geometric increase in the pressure wave as it is reflected off walls, floors, and ceilings.[28] These factors may explain the greater incidence of critical injuries and casualty mortality from the bombings in Beirut, Bologna, Cu Chi, and the Birmingham and Guildford pubs, as compared with those events occurring primarily in outdoor locations or with relatively small explosive force, such as the Old Bailey, Jerusalem, Craigavon, and Belfast bombings (Fig. 1).

Theoretically, bodily injury from the blast wave is caused by the passage of the blast wave through the body, resulting in a disruption of tissues at air-liquid interfaces through the effects of "spalling" and implosion.[15,28,30,31] Thus, air-containing organs such as the ears, lungs, and bowels are most susceptible to this form of injury, with intestinal injury predominating in victims of underwater blast, whereas tympanic membrane and pulmonary injury predominate in victims of air blasts.[31,32] The radiologic and pathologic manifestations of injury to these organs take the form of parenchymal hemorrhage and laceration similar to blunt contusions,[11,15,16,28,31,33-35] with immediate deaths most often caused by massive coronary and cerebral air embolism.[31,36] Late deaths are generally attributable to progressive pulmonary insufficiency. Actually, these primary blast injuries are rare among survivors of air blasts, in contrast to underwater blast victims, presumably because there is a rapid dissipation of the pressure wave in air within a short distance of the point of deto-

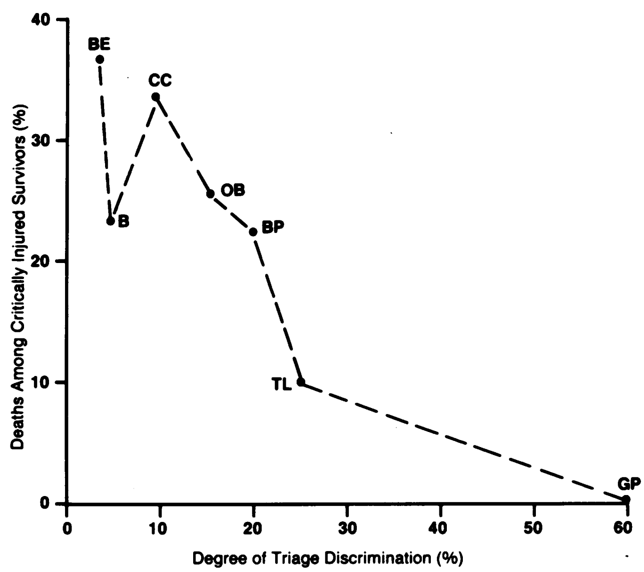

FIG. 4. Relationship between mortality of critically injured terrorist bombing victims and triage discrimination (difference between noncritical injuries of total survivors and noncritical injuries of hospitalized survivors). Multiple linear regression analysis shows $r^2 = 0.855$. See Figure 3 for abbreviation key.

nation.[3,15,16,19,28,37] Those victims close enough to an explosion to be susceptible to blast injury would most likely be killed by secondary and tertiary blast effects.[1,16] This principle is supported by the very low incidence of lung injury caused by blast (0.6%) found among the 2934 immediate survivors reported in this review (Table 2). The substantial mortality rate in that small set of immediate survivors in whom this injury does occur (11%) emphasizes the importance of its early detection and aggressive treatment.[11,31]

Secondary effects of air blasts caused by debris set in motion by the dynamic pressure of the shock wave, and tertiary effects caused by the victim's body being displaced into other objects, are the forms of injury that predominate among surviving casualties of terrorist bombings.[1,11,16,28] Most of these injuries are relatively minor and nonlife-threatening soft tissue wounds and bone fractures,[26] as was found in our combined casualty population (Fig. 2). Virtually all major injuries of the head, chest, and abdomen may also be attributed to these mechanisms.[28] Miscellaneous effects of air blasts include burns, inhalation of noxious gases, and crush injuries from building collapse. Burns are uncommon among survivors of bombings and are typically caused by the brief thermal flash of the explosion. They therefore tend to be superficial and occur only on exposed body areas.[38] This accounts for the low mortality of these injuries (Table 2). Very powerful explosions, explosions at indoor locations, and the occurrence of secondary fires resulting from bombings can incur major burns with higher mortalities.[10] Building collapse is a relatively unusual but devastating sequela of bombings that likewise results from large quantities of explosive.[1,6,11]

Patterns of Injury and Mortality

Distinctive patterns of injury and mortality emerge from an analysis of the combined population of 3357 bombing casualties reviewed herein. The proportion of immediate deaths among total casualties appears to be related to the overall severity of the explosion in terms of the magnitude of explosive force, whether the explosion took place at an indoor location, and whether there was an occurrence of building collapse (Fig. 1). Although the multiple injuries suffered by virtually all immediate fatalities tend to obscure specific causes of death, the type of trauma most commonly found in this population was head injury.[7,15,16] Injuries of the chest and abdomen were the next most common causes of immediate deaths from terrorist bombings (Table 2). These are the same injuries that most commonly cause death in all other forms of trauma, suggesting that this pattern may be a reflection of the tolerance of these body systems to severe injury.[39]

The incidence of specific injuries among survivors of bombing incidents follows a similar pattern, with head injuries predominating among those injuries associated with late death (Fig. 2). The incidence of various injuries has been related to clothing distribution and relative degrees of exposure, because torso and extremity trauma occur less commonly, and head and neck trauma occur more commonly than would be predicted on the basis of the total body surface areas at risk.[1,3,5,11,12,16,26]

There are two perspectives from which the relationship between specific injuries and ultimate mortality of survivors can be viewed. The contribution of deaths from one body system injury to total deaths is the conventional method used to express this relation. This reflects the degree to which the involved organs can tolerate injury, or the physiologic consequences of tissue destruction.[16] Head injury caused the most significant number (52%) of the late deaths of immediate survivors of terrorist bombings, followed by injury to the chest and abdomen, burns, and traumatic amputation (Table 2). Again, these are the typical causes of death in virtually all blunt trauma.[39,40] The mortality of a specific injury, representing the number of deaths caused by an injury in relation to the total number of casualties having that injury, indicates the vulnerability of an organ system to damage. It is interesting to note that, by this latter measurement, head injury actually caused the least number of deaths among survivors of bombings (1.5%), whereas abdominal injury, thoracic injury, and traumatic amputation accounted for, respectively, the highest specific mortality rates (Table 2). This probably reflects the predominance of relatively minor wounds of the head and neck,[26] as well as the natural protection afforded the underlying organs in all these anatomic areas. The skull and chest wall, for example, provide a better shield from injury than does the relatively soft abdominal wall. The high mortality incurred by abdominal injuries has been noted by other authors.[3,15] The surprisingly high mortality caused by traumatic amputation (11%) is most likely a reflection of the magnitude of blunt force necessary to cause this injury, with death probably due to associated critical injuries. It may thus be considered a "marker" of severity, and an indication for aggressive management whenever it is found.

Emotional shock affects a substantial portion of bomb blast victims, particularly those who are women.[3,13] Emotional shock should therefore be considered one of the major injuries to be expected in terms of the potential for long-term psychological disability. Disaster planning should include provisions for emotional evaluation and rehabilitation of casualties.[26]

Injury Management

The management of bodily injuries resulting from terrorist bombings should involve aggressive and thorough unroofing, debridement of devitalized tissue, cleansing, and delayed primary closure of the soft tissue wounds that predominate, regardless of how minor or innocent the wounds appear.[3,5,13,15,18,19,41] These injuries are typically caused by high velocity, irregular fragments of shrapnel, and debris that result in extensive tissue destruction and contamination. In view of the high mortality associated with abdominal injuries, a liberal approach to early laparotomy is warranted for any victim with a potential for abdominal injury (Table 2). Delay in the appropriate treatment of critical injuries has been shown to be a significant determinant of mortality.[10,13,16,23] These principles again indicate that the immediate availability of experienced surgeons and surgical support personnel and facilities is crucial to minimizing the morbidity and mortality of immediate survivors of these incidents.

Patterns of Severity

The pattern of injury severity among survivors of terrorist bombing disasters is consistently characterized by an overwhelming predominance of relatively minor and nonlife-threatening trauma.[3,5,10,11,13,16,18,24–26] The 81.3% incidence of noncritical injuries in immediate survivors documented in this review (range of 66–97.5%) confirms such a pattern (Table 3). This can be attributed to the rapid dissipation of the energy of the primary blast wave and secondary missiles in air, which tends to be further reinforced by the protective effects of the clothing and the skin of victims. The external soft tissues thus bear the brunt of these dissipated forces, as demonstrated by the high incidence of soft tissue injury (Fig. 2). Most casualties who suffer severe injuries are generally among those immediate fatalities who die before reaching medical care (Fig. 1).

One implication of this high incidence of noncritical injuries relates to the artificially low level of mortality rates that are based on the total group of survivors (Fig. 1). It would seem most appropriate to base mortality rates on the relatively small population of critically injured survivors who are truly at risk of death, and in which group, at least theoretically, virtually all deaths should occur.[10,23] The 31 deaths that occurred among the 251 critically injured, evaluable immediate survivors of this review provides a "critical" mortality rate of 12.4% (Table 3). This is considerably greater than the 1.4% mortality rate calculated from the total survivor population or the 4.4% mortality rate of all hospitalized immediate survivors, yet the critical mortality rate should more accurately reflect the effectiveness of medical care provided the immediate survivors, as well as the influence of various factors that influence that care. It is thus the most appropriate figure to use in comparing the results of different disasters.

The retrospective determination of ISS in survivors of terrorist bombings provides an objective and standardized method of assessing the distribution of injury severity among casualties.[21] The value of this application of the ISS in the analysis of critical injuries, critical mortality, and overall effectiveness of medical management after these disasters has been demonstrated.[5,10,11]

The Role and Importance of Triage

These principles of casualty management and injury severity distribution have an important bearing on the process of triage, which, in view of the sudden and unexpectedly large number of victims, must be an integral part of the delivery of medical care after terrorist bombings. The goal of triage is to identify that minority of critically injured casualties who require immediate treatment, in order to render that treatment as soon as possible.[23,24,27] The extent to which both overtriage and undertriage are carried out is the primary determinant of the overall efficiency of this process, and it is generally accepted that undertriage is the more necessary to avoid.[22] The results of casualty triage in the combined population of survivors analyzed in this review indicate that this goal was achieved, with an undertriage rate of only .05%. The price of achieving this low undertriage, however, was a high rate of overtriage (Table 3), a finding noted by others.[23] Although overtriage is considered more of an administrative problem than a medical problem under routine circumstances,[22] the inundation of hospitals with large numbers of noncritical casualties in the aftermath of a disaster may very well interfere with the capability of limited medical resources to provide timely and adequate care for critically injured victims.[10] The direct relationship between overtriage and critical mortality that emerged from the data in this literature review (Fig. 3) confirms that overtriage can result in the loss of potentially salvageable lives. This finding was reinforced by the inverse relationship found between triage discrimination and critical mortality resulting from these bombing incidents (Fig. 4). The importance of triage accuracy as a survival determinant in mass casualty events is established by these data. Early triage should be instituted near the scene of a disaster, and this initial sorting should be reinforced at a second designated triage area.[24] These triage areas should be separate from the hospital providing definitive care so as to minimize interference with the treatment of critically injured victims. The confusion and consequent loss of life that can result from disorganized rescue and triage efforts have been documented by others.[11,27] These methods should serve to optimize triage efficiency and thus minimize mortality.

Of the combined population of this review, three immediate survivors who had suffered expectant injuries died. All three casualties died within hours of injury after being triaged for immediate care.[10,20] This expectant triage category includes those injuries with such a high probability of mortality that treatment should be withheld, in order to most efficiently allocate the limited time and resources available in mass casualty scenarios. The hospitalization or evacuation of expectantly injured casualties for urgent treatment should be considered as overtriage, and in the assessment of critical mortality, these casualties should not be included in the critically injured population. Their inevitable death should also be included among immediate fatalities, since medical care should not be rendered. This principle was followed in computing the critical mortality and overtriage rates among the survivors of the Cu Chi incident (Table 3), in which two expectant injuries were evacuated for immediate care.[20] Adherence to these concepts should minimize an artificially unfavorable skewing of mortality rates, allowing these rates to accurately reflect the quality of medical care received.[10]

In summary, relatively few health care providers in the United States have any experience with the principles of mass casualty management after terrorist bombings, since this country has, for the most part, been spared of such attacks.[27] The significant organizational problems, the large number of mutilating injuries requiring immediate treatment, and the substantial psychological impact on the community as a whole can easily overwhelm the average hospital that may be suddenly tasked with these responsibilities. Different types of disasters, such as fires, floods, earthquakes, or shootings, can be expected to result in very different patterns of injury, injury severity, and mortality.[25] The purpose of this review was to define only those broad principles that are generally applicable to the effective delivery of medical care in the aftermath of terrorist bombing disasters, as derived from a large combined experience documented in the medical literature. It is evident that accurate triage is a significant determinant of casualty survival. The explosive force of the bomb, the environment in which the explosion occurs, anatomic sites of injury, and the time interval between injury and treatment are also factors that may correlate with ultimate casualty outcome. Analysis of past disasters allows for a realistic appreciation of the magnitude and nature of problems to be expected. This can significantly contribute to minimizing casualty mortality in the future.

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