Principles of Mass Casualty Management Following Terrorist Disasters

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Those who cannot remember the past are condemned to repeat it.
—George Santayana

Science is the great antidote to the poison of enthusiasm and superstition.
—Adam Smith

May you live in interesting times.
—Chinese proverb

Interesting times, indeed. We are now living in an era of unprecedented medical advances in patient care and quality of life, but at the same time face some of the most daunting challenges to ever confront the surgical profession. The 3 papers featured in this issue of *Annals of Surgery* that describe the unique characteristics and management principles of mass casualties from recent terrorist violence in Israel illustrate one of the most prominent and timely of these challenges to our skills, our adaptability to adversity, and to our commitment to the care of the injured. The massive numbers of casualties that exceed the resources of most hospitals, the victimization of innocent civilians, including children, and the especially severe and extensive patterns of injury that characterize current terrorist attacks, go so far beyond the standard surgical training and experience of most of us, that a basic change in mindset is necessary in our approach to medical care of these victims to maximize the salvage of life.

Almogy et al document the high ratio of dead:wounded from suicide bombings to range from 5–22, which is an order of magnitude above the 1:2 – 1:5 reported in conventional military combat experiences. Peleg et al report the inpatient mortality following terrorist bombings and shootings to be two- to 3-fold higher than that following motor vehicle crashes and other standard forms of trauma.

These studies by our surgical brethren in Israel offer important lessons to surgeons around the world who rarely, if ever, experience true mass casualty disasters involving bodily injury, and yet who are increasingly likely to face such scenarios in the near future in the current political climate. Until recently, the United States, in particular, has been largely spared the horrors of terrorist bombings and shootings that Israelis experience virtually every day and, as a result, we are poorly prepared for the demands of caring for such large numbers of severe injuries. Although Americans have suffered several terrorist attacks and substantial loss of life from these causes over the past 20 years, and the threat of more attacks rises, we tend to have a short memory. The same mistakes continue to

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occur in our preparedness, response, and approach to casualty disposition and management following each of these events, including, among many others, the 1983 truck bombing of U.S. Marines in Beirut, the 1993 New York City World Trade Center bombing, the 1995 Oklahoma City bombing, the 1996 Centennial Olympic bombing in Atlanta, and the World Trade Center destruction in 2001. It is past time that we begin taking to heart the critical need to learn the basic principles of mass casualty management from terrorist disasters which have been so well established from decades of published experiences, and which are further emphasized in these 3 studies from Israel.

The first lesson to glean from these papers is that bombings and shooting massacres are, historically, by far the most common form of terrorist violence. These means continue to be used, and therefore are most likely to be used in the future. Even within the borders of the United States, millions of dollars of property damage, tens of thousands of casualties, and hundreds of deaths have resulted from terrorist bombings over the past 2 decades.[1] These mechanisms are the easiest and least costly methods of achieving the terrorist goals of large-scale casualties. This explains why surgeons, along with other acute care trauma specialists, must be integrally involved as leaders in the field of disaster management, and in local hospital and community disaster planning. We must develop the necessary expertise that we now tend to lack in the biology of explosive injury, its known patterns of severity, and the unique principles of mass casualty management that are so different from our routine approaches to trauma. We must resist our current tendency to become overly enamored with the "weapons of mass destruction" of biologic, chemical and radiologic attacks, in terms of funding priorities and resource allocations that are wholly disproportionate to the clear reality of the terrorist bombing threat.

All 3 studies in this issue emphasize the importance of triage to the proper management of mass casualties from terrorist bombings and shootings, due to the fact that these disasters typically result in large numbers of casualties who are not critically injured. Einav et al report only 20% of casualties with critical injuries requiring urgent care, Almogy et al only 22%, and Peleg et al only 23%, consistent with the patterns reported in virtually all other terrorist bombings.[2] This leads to an inundation of scarce medical resources with hundreds of victims who do not require immediate attention (overtriage), which then threatens to delay the recognition and care of that small minority with urgent and salvageable life threatening injuries at immediate risk of death (undertriage). Almogy et al stress the need to avoid providing care to those "expectant" survivors so severely injured that their ultimate salvage is unlikely, as this form of overtriage wastes limited resources and may endanger the lives of those with less severe injuries. For this reason, Peleg et al emphasize that injuries of moderate severity, rather than greatest severity, should take priority.

Thus, rapid and accurate triage is essential to minimize mortality among survivors, explaining why the triage officer is typically an experienced trauma surgeon. It has been shown that mortality among critically injured survivors of terrorist bombing disasters is directly related to the magnitude of overtriage.[2] Triage should be performed outside of the hospital as an aggressive screening process, to prevent all except those in most need of urgent attention from overwhelming this critical medical resource. This is one example of how mass casualty disasters require a major paradigm change from our routine approach to emergency room care with essentially limitless resources, in which triage is rarely used, as all patients are admitted for full individual evaluations without regard to their urgency or salvageability.

Several cogent lessons about the approach to medical care of mass casualties can be gleaned from these authors. Einav et al and Almogy et al both make the point that the sheer numbers of potentially urgent injuries require that initial assessment be rapidly performed by small medical teams, and that only minimal acceptable care be applied just to keep patients alive long enough to reach definitive care. Casualties must continually be moved in a unidirectional flow to successive echelons of care (ie, holding areas, ICU, operating room, other hospitals, depending on the nature of injuries), minimizing or eliminating any use of diagnostic laboratory and imaging tests, while casualty influx continues. The length of time influx continues is unpredictable in any given disaster, and usually not known because of breakdown in communications between the scene and hospital. Therefore, a plan for relief of medical teams after several hours, and for evacuation of treated casualties elsewhere to make room for more, becomes necessary.

The principle of rapid and abbreviated care also applies to the operating room, where Almogy et al stress the application of classic damage control principles until casualty influx ceases. Surgeons must be prepared for especially complex and difficult wounding patterns that are not typically seen in routine practice, and that greatly increase morbidity and mortality, such as blast lung, and multiple penetrating injuries from both destructive shrapnel increasingly used in bombs and from automatic firearms. Einav et al demonstrate the importance of coordinated interaction between all area hospitals, so as to equalize the casualty load from the disaster scene to prevent any one facility from being overwhelmed, and to allow a later "secondary distribution" of hospitalized casualties to the most appropriate facilities for definitive care and recovery. Their point that every community hospital must be as fully prepared to deal with mass casualties as any major urban trauma center is one of the most important lessons we can learn. None of these principles and methods are new, as all have been elaborated repeatedly in prior published reports.[3–6]

The failure of Peleg et al to find any significant difference in mortality between survivors of bombings and gunshot disasters is based on all casualties and, thus, is misleadingly diluted out by the majority of noncritically injured survivors who are not really at any risk of death. Had they used the concept of critical mortality, basing the number of deaths only upon the population of critically injured victims in which all deaths occurred, their data actually show a statistically significant higher mortality among gunshot survivors than bombing survivors (32/102, 31.4% versus 33/164, 20%, $P = 0.0411$ by χ^2 analysis). Critical mortality is the more accurate measure of outcome of medical management of mass casualties, and allows a more meaningful comparison of outcomes from different disasters.[2]

The validity of the sophisticated statistical analyses used by Peleg et al and Einav et al is somewhat suspect with regard to our ability to derive any clinically meaningful conclusions from them, in view of the many uncontrollable variables involved in making all the complex decisions being measured. Nonetheless, their attempt to apply science to derive orderly patterns from the apparent chaos and unpredictability of mass casualty events is commendable, and a model we should all follow.

Without reports like these from physicians who have actually faced these challenges, and expended the effort to analyze and disseminate their experience, we have no other reliable way to learn how to prepare for and implement the many unique elements of disaster responses, in view of the relative rarity of true mass casualty events. It is evident that there are distinct patterns of injury and logistical needs that follow terrorist bombings from which general principles of planning and management can be derived for disasters of all types. All that is needed to avoid repeating the mistakes of the past is to read the increasingly abundant literature on this topic, and become actively involved in disaster planning in our own communities. Hopefully this will lead to even more "interesting" times of a happier sort in the future.

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