

Significance of a Level-2, “Selective, Secondary Evacuation” Hospital during a Peripheral Town Terrorist Attack

Dagan Schwartz, MD;^{1,5} Moshe Pinkert, MD, MHA;² Adi Leiba, MD;² Meir Oren, MD;⁴ Jacob Haspel, MD;⁴ Yehezkel Levi, MD;³ Avishay Goldberg, PhD;⁵ Yaron Bar-Dayan, MD, MHA^{2,5}

1. Israeli EMS, Magen David Adom
2. Home Front Command Medical Department, Israel
3. Israeli Defense Force Medical Corps, Surgeon General Headquarters
4. Hillel Yafe Hospital, General Manager Office, Israel
5. Faculty of Health Sciences, Ben Gurion University, Beer-Sheva, Israel

Correspondence:

Col. Dr. Y. Bar-Dayan, MD, MHA
Chief Medical Officer, Israeli Defense
Force Home Front Command
16 Dolev St.
Neve Savion, Or-Yehuda
ISRAEL
E-mail: bardayan@netvision.net.il

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Abbreviations:

ALS = advanced life support
BLS = basic life support
EMS = emergency medical services
HFC = Home Front Command
MCI = mass-casualty incident
MOH = Ministry of Health

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Abstract

Introduction: Mass-casualty incidents (MCIs) can occur outside of major metropolitan areas. In such circumstances, the nearest hospital seldom is a Level-1 Trauma Center. Moreover, emergency medical services (EMS) capabilities in such areas tend to be limited, which may compromise prehospital care and evacuation speed. The objective of this study was to extract lessons learned from the medical response to a terrorist event that occurred in the marketplace of a small Israeli town on 26 October 2005. The lessons pertain to the management of primary and secondary evacuation and the operational practices by the only hospital in the town, which is designated as a Level-2 Trauma Center.

Methods: Data were collected during the event by Home Front Command Medical Department personnel. After the event, formal and informal debriefings were conducted with EMS personnel, the hospitals involved, and the Ministry of Health. The medical response components, interactions (mainly primary triage and secondary distribution), and the principal outcomes were analyzed. The event is described according to Disastrous Incidents Systematic Analysis Through Components, Interactions, Results (DISAST-CIR) methodology.

Results: The suicide bomber and four victims died at the scene, and two severely injured patients later died in the hospital. A total of 58 wounded persons were evacuated, including eight severely injured, two moderately injured, and 48 mildly injured. Forty-nine of the wounded arrived to the nearby Hillel Yafe Hospital, including all eight of the severely injured victims, the two moderately injured, and 39 of the mildly injured. Most of the mildly injured victims were evacuated in private cars by bystanders.

Five other area hospitals were alerted, three of which primarily received the mildly injured victims. Two distant, Level-1 Trauma Centers also were alerted; each received one severely injured patient from Hillel Yafe Hospital during the secondary distribution process.

Emergency medical services personnel were able to treat and evacuate all severely and moderately injured patients within 17 minutes of the explosion. A total of 12 of the 21 ambulances arriving on-scene within the first 20 minutes were staffed by EMS volunteers or off-duty workers.

Conclusion: When a MCI occurs in a small town that is in the vicinity of a Level-2 Trauma Center, and located a >40 minute drive from Level-1 Trauma Centers, the Level-2 Trauma Center is a critical component in medical management of the event. All severely and moderately injured patients initially should be evacuated to the Level-2 Trauma Center, and given advanced, hospital-based resuscitation. The patients needing care beyond the capabilities of this facility should be distributed secondarily to Level-1 Trauma Centers. To alleviate the burden placed on the local hospital, some of the mildly injured victims can be evacuated primarily to more distant hospitals. The ability to control the flow of mildly injured patients is limited by the large percentage of them arriving by private cars. The availability of EMS in small towns can be augmented significantly by enrolling off-duty EMS workers and volunteers to the rescue effort. Level-2 hospitals in small towns should be prepared and drilled to operate in a “selective evacuation” mode during MCIs.

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Introduction

The number of mass-casualty incidents (MCIs) caused by terrorist attacks has increased over the last decade.¹⁻⁴ When a MCI occurs in the vicinity of smaller hospitals, but far from Level-1 Trauma Centers, a decision must be made regarding the optimal use of hospital resources. Several factors must be considered, including the: (1) number of casualties; (2) types of injuries; (3) evacuation capabilities; (4) distances to area hospitals; (5) expected flow of additional patients; (6) hospital capabilities; and (7) availability of evacuation vehicles.

On one side of the spectrum, MCIs can occur in large metropolitan areas with ≥ 1 Level-1 Trauma Center,^{3,4} and on the other, incidents can occur in remote areas without a nearby hospital or with a hospital having only minimal treatment capabilities.² When the latter occurs, the nearby hospital can serve as an "evacuation hospital", charged with receiving and stabilizing the casualties and transferring all those needing further care to other facilities. Once designated, the hospital's resources are concentrated in the emergency department and operating rooms, providing initial stabilization for wounded victims and secondarily evacuating all patients requiring hospitalization to more comprehensive facilities.² However, not all incidents fall into one of the two situations described. Mass-casualty incidents also can occur in areas where the nearest hospital is not a designated Level-1 Trauma Center, but has treatment capabilities beyond initial stabilization. During a recent MCI in Netania, Israel, most casualties were evacuated to the nearby Level-3 hospital (Laniado), which was able to care for all of the mildly injured victims and for some of the moderately wounded who required hospitalization. The hospital secondarily distributed all severely injured and some of the moderately injured victims to other, higher-level hospitals. This operational mode was designated as a "semi-evacuation" hospital.⁵

On 26 October 2005, at 15:41 hours (h) a suicide bomber blew himself up in a crowded market in the small town of Hadera, within a four-minute drive of a Level-2 hospital. The purpose of this study was to evaluate the overall medical response to this event. The responses of the nearby Level-2 hospital and those of the more distant higher-level hospitals, including those hospitals receiving patients from the secondary distribution process were examined. The aim of this study was to determine the appropriate role for a Level-2 hospital when it is the only local hospital to respond to a MCI. An additional aim was to assess the prehospital phase and the ways in which the emergency medical services (EMS) of this relatively small town managed the incident.

Pre-Event Organization

Operation Centers, staffed 24-hours-a-day, are operated by the national EMS and the Medical Department of the Israeli Home Front Command. These Centers can communicate with all relevant organizations, acquiring and transmitting real-time information and providing instructions necessary to manage MCIs and other medical emergencies. These relevant organizations include all of the Israeli general hospitals, EMS district headquarters, other

military or home-front command units, the fire brigade, police headquarters, search-and-rescue units, military medical units including nuclear, biological, and chemical units, the Israeli Air Force, and the Hazardous Materials Information Center. These Operation Centers also communicate directly with the Ministry of Health (MOH).

National EMS, Magen David Adom—The National EMS system is comprised of 11 districts, each with its own dispatch center. Each Communication Center can communicate with other nearby Communications Centers and with the National EMS Communications Center located in Tel-Aviv. Once a possible MCI is reported to a District Communications Center, the district MCI Protocol is activated. This includes immediate activation via radio communication and pager notification of all of the district employees and volunteers. Additional agencies and the National Communication Center are notified simultaneously. The district Communication Center, in coordination with the National Communication Center, may choose to activate the MCI protocol in adjacent districts or even nationwide, depending on the number and type of casualties, as well as other relevant characteristics of the MCI, including available resources.

Chain of On-Scene EMS Command—The most senior EMS person arriving on-scene in the first ambulance is designated as the Scene Commander (SC). The SC opens a cellular line of communication with the District Communications Center and is identified by wearing an EMS Scene Commander cap and vest. The SC is charged with: (1) evaluating the scene; (2) directing all arriving EMS units and personnel; and (3) continuously reporting to the Communications Center regarding recommended routes for arrival and evacuation, special precautions to be taken, and the number of units needed. The SC also supervises and directs the evacuation of the injured. The decisions regarding the evacuation destinations are made by the Communications Center and based on: (1) medical information provided by treating personnel regarding available EMS resources; and (2) evacuation times and reports from EMS representatives at the relevant hospitals. When additional EMS personnel arrive on-scene, a more senior worker may assume the role as the SC. Each patient is assessed by the SC or by a treating paramedic or physician, and triaged into two categories: "urgent" or "non-urgent". Depending upon the size of the incident and the available resources, the SC may delegate authority to a Medical Commander, who ensures appropriate medical care is provided to all of the victims, and to an Evacuation Commander, who ensures that all of the evacuees are assessed appropriately, stabilized, and evacuated by the most suitable personnel available (basic life support (BLS) provider vs. advanced life support (ALS) provider).

Methods

Post-MCI debriefings were held among all relevant organizations including the HFC Medical Department, National EMS, treating hospitals, the Medical Air Force

Civilian Medical Teams	Emergency Medical Services -29 BLS Ambulances -13 ALS Ambulances -1 MCV
Military Medical Teams	-3 medical helicopters with air force medical teams -Military team (with ambulance, physician, 3 medics) from a neighboring military clinic
Hospitals	-6 general hospitals (out of 24 in Israel)
Medical command and operations	-Home Front Command Operational Center -EMS District and National Operational Center -Police headquarters

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Table 1—Units involved in mass-casualty incident response (ALS = advanced life support; BLS = basic life support; MCV = mass-casualty vehicle)

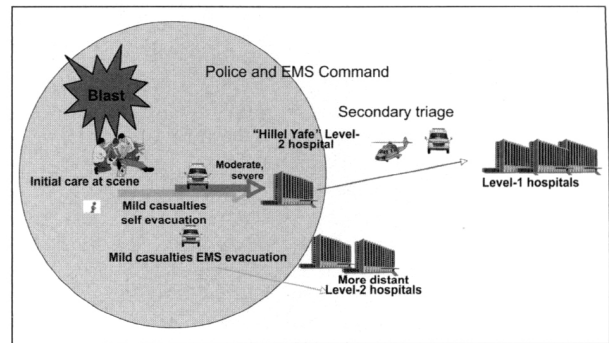
Unit, and the Ministry of Health. Each debriefing was structured according to a standardized protocol—with each organization reporting its data and answering questions. To allow free communication between organizations, such debriefings were closed to the media. The data were organized according to the Disastrous Incidents Systematic Analysis Through Components, Interactions, Results methodology (DISAST-CIR).⁵

Classification of injury severity differs by levels of care. The National EMS classifies the injured victims either as “urgent” (patients with potential life- or limb-threatening injuries) or “non-urgent”. Upon arrival to the Emergency Department, these patients are classified as “mildly”, “moderately”, or “severely” injured, and later are classified retrospectively according to the Injury Severity Score (ISS).

Results

The town of Hadera (80,000 residents) has one hospital within the city limits (Hillel Yafe). It is designated as a Level-2 Trauma Center and lacks neurosurgical and cardiothoracic surgery capabilities. There are three additional hospitals within a 30-minute radius of the town, none of them are Level-1 Trauma Centers. Larger, Level-1 Trauma Centers are approximately 40 minutes away by ground transport, and are located within large metropolitan areas (Tel-Aviv and Haifa).

Hospitals received early notification of a MCI both from EMS and the Home Front Command (HFC) Medical Department. The HFC instructed the hospitals to activate their MCI protocols. The direct connections between the National EMS, the HFC Medical Department, and the Air Force Command allows for the rapid reinforcement by medical evacuation helicopters to primary evacuation hospitals or for secondary distribution. Home Front Command officers were dispatched to the



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Figure 1—The components of the medical response and the interactions between them

disaster zone, EMS Center Headquarters, and hospitals. Home Front Command officers, physicians, and nurses gathered information and transmitted it to the Operations Center, hospitals, EMS, and other relevant organizations.

The components of the medical response are illustrated in Table 1 and the interactions between them are illustrated in Figure 1. All urgent casualties were evacuated by EMS land ambulances to the nearby Hillel Yafe Hospital (3–5 minute travel time). Non-urgent victims were distributed by EMS to Hillel Yafe or to three additional hospitals: Laniado, a Level-3 Trauma Center, and two Level-2 Trauma Centers: Ha'emek and Meir (Figure 2). The medical management timetable is shown in Table 2. Three mild casualties and one severely injured victim were evacuated by private ambulances to the nearby Hillel Yafe Hospital, and 18 mild casualties arrived by private cars. The self-evacuated patients started arriving at the hospital nine minutes after the explosion (before any of the ambulances), and continued to arrive until four hours after the event. All self-evacuated patients were injured mildly, many of them suffering from stress reactions.

The suicide bomber and four of the victims died at the scene. A total of 58 casualties were primarily evaluated and treated at the four mentioned hospitals (Table 3). The National EMS evacuated 36 of the 58 victims, four additional victims were evacuated by private ambulances, and the remaining 18 evacuated themselves from the scene. Of the 36 patients evacuated by the National EMS, six were classified as urgent, and the remaining 30 were considered non-urgent. Upon arrival to the hospitals, eight victims were classified as severely injured, two-moderately injured, and 48 mildly injured (including stress reactions).

Patient triage and care at Hillel Yafe Hospital is shown in Figure 3. Two patients with severe head injury later were distributed secondarily from Hillel Yafe to two Level-1 Trauma Centers. One severely injured patient died in the emergency department within one hour of arrival, and an additional patient died 10 days post-injury from sepsis.

Types of Injuries

The major injuries sustained from this event were caused by penetrating trauma (Table 4). The bomb contained round metal objects that caused most of the severe injuries

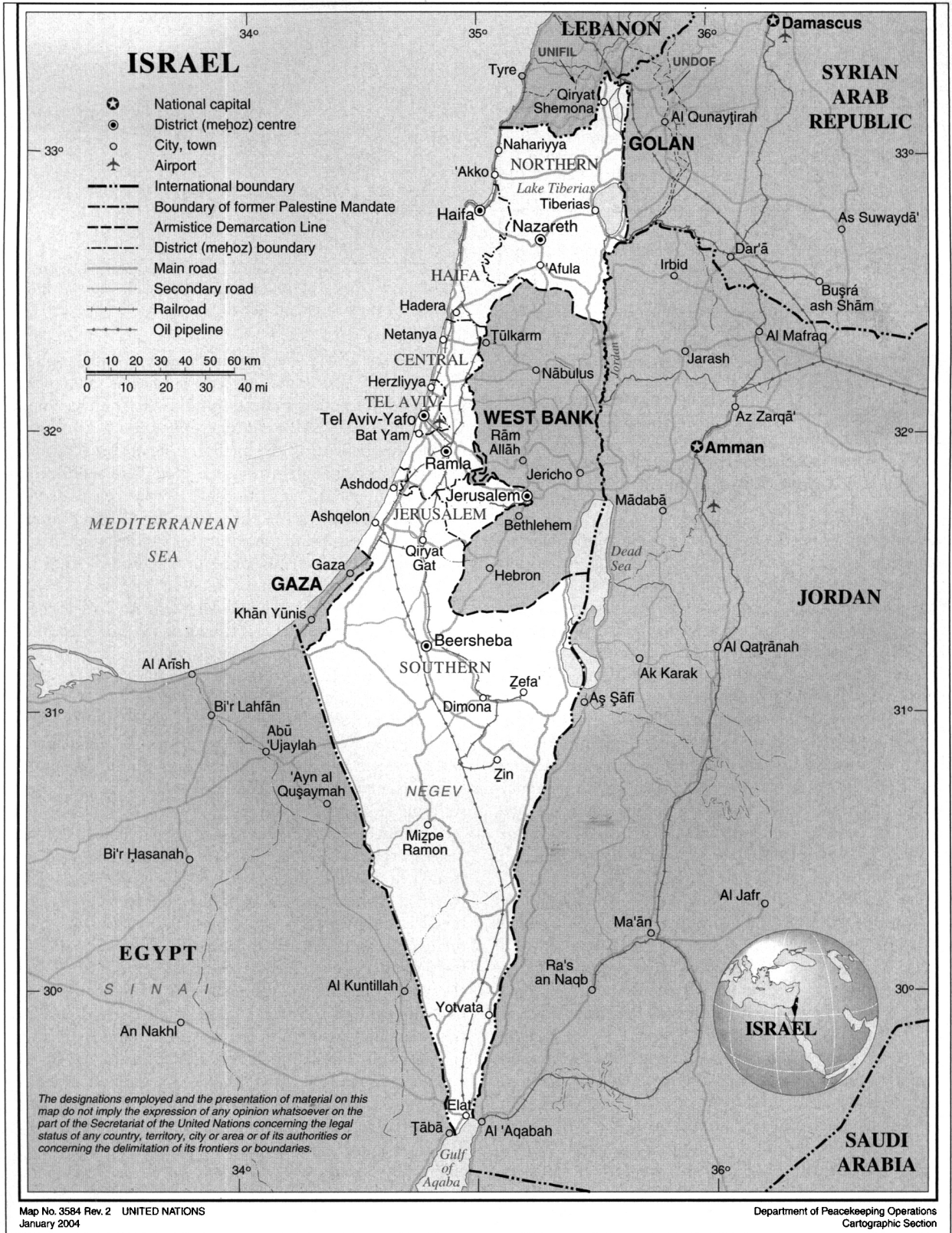


Figure 2—Map of Israel

Source: United Nations Cartographic Section

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Time from Incident (hours)	Actual Time (hours)	Description of Event
0:00	15:42	Suicide bombing at Hadera market
0:03	15:45	First ALS and BLS ambulances arrive on-scene
0:03	15:45	Hillel Yafe Hospital notified
0:08	15:50	First casualty arrives at the hospital (mildly injured via private vehicle)
0:09	15:51	First urgent victim evacuated from the blast site
0:17	15:59	Last urgent victim evacuated from the blast site
0:55	16:37	Secondary helicopter transfer of victim with severe head injury from Hillel Yafe
2:48	18:30	Secondary ambulance transfer of victim with severe head injury from Hillel Yafe

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Table 2—Timetable of the medical response (ALS = advanced life support; BLS = basic life support)

Hospital	Mild	Moderate	Severe	Total	Admissions	Surgery
Hillel-Yafe	39 (18)*	2 (2)*	8 (7)*	49 (28)*	21	10
Laniado	3 (3)*	--	--	3 (3)*	0	0
Meir	2 (2)*	--	--	2 (2)*	0	0
Haemek	4 (4)*	--	--	4 (4)*	0	0
Total	48 (27)*	2 (2)*	8 (7)*	58 (36)*	21	10

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Table 3—Hospital data, admissions, and operations

*in parenthesis appear the number of patients evacuated by emergency medical services

(Figure 4). Injury severity scores of the wounded are listed in Table 5. Ear injuries (hearing loss and tinnitus) resulting from the blast were identified in 15 (58%) of the 26 mildly injured patients evaluated. Perforated tympanic membranes were identified in eight of the victims.

All nine patients primarily evacuated to more distant hospitals were discharged within 24 hours. None of them needed urgent surgeries or lifesaving procedures.

EMS Staff and Vehicles

At the time of the attack in Hadera, there was one ALS and two BLS units (one of them busy providing medical care for routine calls) on-shift, and two additional private ambulances. Within one minute of the initial report of the explosion, the EMS District MCI Protocol was activated, and the national protocol was activated within two minutes.

Ambulances began to arrive at the scene three minutes after the explosion. The EMS buildup of the on-scene capacity is listed in Table 6. Despite the fact that at the time of the explosion, the local EMS had only one ALS and one BLS active shift units available, 21 units arrived to the scene within the first 20 minutes following the explosion. Most of the units arriving at the scene were off-duty EMS workers or EMS volunteers who either were with an ambulance at their private residence or arrived to the local EMS station and took unassigned ambulances. Additional units arrived from neighboring EMS regions and private ambulance services.

Urgent patient evacuation of victims from the scene began nine minutes after the explosion, and the last urgent victim was evacuated from the scene within 17 minutes. Within 20 minutes, the total number of EMS vehicles that had arrived to the scene was 21. Many additional, off-duty EMS workers and EMS volunteers also arrived on-scene, but the exact time of their arrival was unavailable.

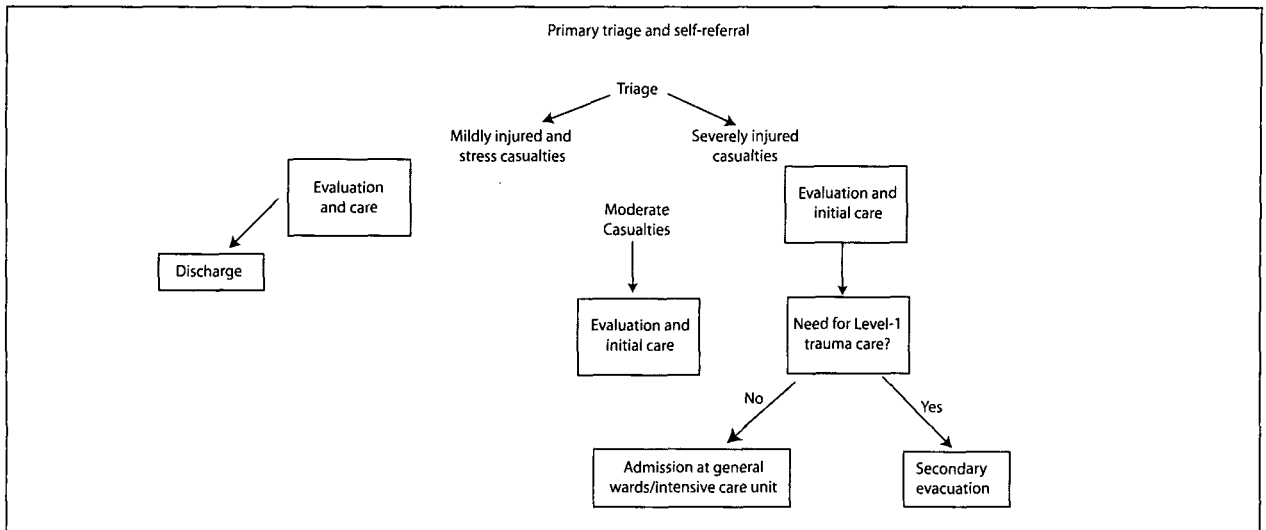
Hospital Care

The local Level-2 hospital received 49 of the 58 casualties (84.4%), including all the severely and moderately injured, as well as 39 of the mildly wounded. This hospital, which has coped with multiple MCIs in recent years, was able to provide definitive care to all of the victims except for two patients with severe head injuries. Those patients were transferred secondarily (one of them after undergoing laparotomy).

Discussion

This recent terrorist bombing in Hadera demonstrates the role that a local Level-2 Trauma Center can play in this type of MCI, as well as the supporting role played by more distant Level-1 Trauma Centers and other non-Level-1 area hospitals.

In accordance with national MCI guidelines, the EMS diverted nine mildly injured casualties to more distant hospitals. The rationale for this strategy was to reduce the patient burden on the local hospital, allowing staff to con-



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Figure 3—The principles of triage and patient care used at Hillel Yafe Hospital

Patient Number	Type of injury and outcome of all severely injured patients	Outcome
1	49 y.o. male with right thigh penetrating injury and penetrating abdominal injury. Severe hypovolemic shock	Died within one hour of arrival to the emergency department
2	35 y.o. female with penetrating head injury	Secondary airborne transport to Tel Hashomer Level-1 Trauma Center
3	21 y.o. with penetrating abdominal and penetrating head injury	Urgent laparotomy at Hillel Yafe followed by secondary ambulance transport to Beilinson Level-1 Trauma Center
4	67 y.o. female with penetrating abdominal injury and right thigh injury (IVC tear, bowel injury, bilateral foot injuries)	Underwent multiple surgeries received factor 7, died from sepsis on day 10
5	45 y.o. female with head, chest, and abdominal injuries	Intubated, chest drain. Admitted to an intensive care unit
6	17 y.o. male with facial, hand, and elbow injuries	Underwent orthopedic surgeries
7	49 y.o. male with facial, left forearm, and elbow injuries	Underwent orthopedic surgeries
8	60 y.o. with open left leg fracture, fracture of clavicle and shrapnel injury to left arm and eyes	Underwent orthopedic surgeries

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Table 4—Severely injured victims (Hillel Yafe Hospital; IVC = inferior vena cava; y.o. = year old)



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Figure 4—X-ray of bomb-emitted metal balls

centrate on the care for all severely and moderately injured patients. The fact that all patients primarily evacuated to more distant facilities were discharged within 24 hours is a testimony to the appropriateness of the field triage of these victims. However, the number of mild casualties arriving to the local hospital was 39, more than twice the number it had received from EMS. The large number of mildly injured arriving by non-EMS vehicles (some within the initial minutes of the explosion) is a recurring phenomenon, and must be taken into account during the response planning and management of such events.⁶ Anticipating the need for the secondary transfer of patients to distant Level-1 Trauma Centers, the HFC ordered two Air Force medical evacuation helicopters to land at Hillel Yafe

Hospital	ISS <9	9 ≤ ISS <16	ISS ≥16	Dead	Total
Hillel Yaffe	40	4	5	--	49
Laniado	3	--	--	--	3
Meir	3	--	--	--	2
Haemek	4	--	--	--	4
Total	46 (78%)	4 (7%)	4 (7%)	4 (7%)	58 (100%)

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Table 5—Distribution of the original by Injury Severity Scale (ISS) Scores

Time after blast (minutes)	Regular city shift units	Volunteers and off-duty workers	Private ambulances	Units from neighboring areas	Total
3	1 ALS 1 BLS	1 BLS	--	--	1 ALS 2 BLS
4–10	1 ALS 1 BLS	5 BLS	--	--	1 ALS 5 BLS
11–15	1 ALS 1 BLS	1 ALS 6 BLS 1 MCRV	1 ALS 1 BLS	1 ALS 1 BLS	4 ALS 9 BLS 1 MCRV
16–20	1 ALS 1 BLS	2 ALS 9 BLS 1 MCRV	1 ALS 1 BLS	3 ALS 2 BLS	7 ALS 13 BLS 1 MCRV

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Table 6—Emergency medical services unit build-up in the first 20 minutes (ambulances) (ALS = advanced life support; BLS = basic life support)

Hospital.⁷ Additionally, three ALS ambulances were designated for this transfer and sent to the hospital. Despite the anticipation of large numbers of patients for secondary transport, only one medical helicopter and one ALS ambulance eventually were used for secondary evacuation of victims.

In the management of patient distribution during MCIs, multiple options are available regarding primary patient distribution and potential secondary distribution.⁸ Regarding the former, all patients with immediate, life-threatening injuries must be evacuated to the nearby hospital for evaluation and stabilization. Depending on EMS capacities, some of the mildly injured primarily can be distributed to hospitals located further away from the incident site. The magnitude of secondary distribution depends on multiple factors, including the number and condition of the casualties and the capabilities of the receiving hospital. During incidents in which the needs of the patient greatly outweigh those capabilities or when ongoing patient flow is expected, the hospital can function as an “evacuation hospital”, transferring all patients requiring admission (Figure 5). If the nearby hospital can provide definitive care, depending on injury load and local capabilities, only some of the wounded requiring admission must be distributed secondarily. During the Netania event, when the nearby hospital was a Level-3 Trauma Center with limited resources,⁵ all of the severely injured and some of the moderately injured were distributed secondarily to Level-1 Trauma Centers. This operational mode was termed “partial evacuation hospital”. During the Hadera incident,

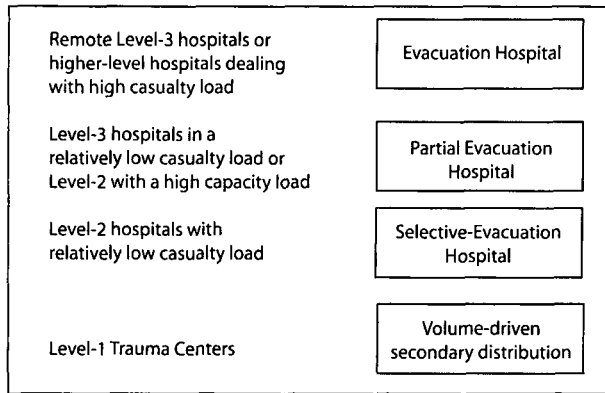
patient load was smaller and the capabilities of the local hospitals were higher. The hospital only selectively distributed two patients with injuries necessitating neurosurgical care, while delivering definitive care to the rest. This mode of operation should be called “selective evacuation hospital”.

On-site management of such events must be based on clear data regarding the number and severity of injuries. Bringing the data to the event managers is the main task of the HFC Medical Operations Center. Previous experiences with terrorist bombing-induced MCIs shows that since events can happen anywhere, all medical personnel in each of the hospitals, not just trauma centers, should participate in Advanced Trauma Life Support preparedness courses, MCI drills, and be prepared for a high casualty flow.⁹ The capabilities of this local hospital in dealing with MCIs were increased significantly in recent years as a result of intense training and MCI drills, and most importantly, as a result of the experience and set-up capabilities acquired through multiple similar MCIs.

The types of injuries seen in this event are similar to other open-space suicide bomber incidents including the most severe injuries were inflicted by metal objects embedded within the bomb. Interestingly, there was a high prevalence (58%) of ear injuries among the mildly injured.

Limitations

This report mainly is a descriptive analysis of the patient outcomes from this incident and was not compared to outcomes in similar incidents when patients were transferred



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Figure 5—Proximal hospital mode of operation during a mass-casualty incident

primarily to Level-1 Trauma Centers. The relatively small number of severely injured victims in this incident hampers such an analysis. The fact that only two victims died after hospital arrival (one of them required resuscitation immediately upon arrival) is in line with mortality rates from

similar incidents.

The fact that a Level-2 medical center was able to successfully manage the majority of the victims also is limited to an incident of this magnitude (it is unlikely that the above-mentioned system would have worked as well for an event with 200 victims) and to the capabilities and experience of the receiving Level-2 hospital.

Conclusions

When a mass-casualty incident occurs in a small town, in the vicinity of a Level-2 Trauma Center (with other Level-1 or 2 centers located within a 30–60 minute drive), this hospital becomes a critical component of medical event management—urgent casualties must be evacuated rapidly to such a facility and given early advanced hospital-based care. Selective secondary distribution to Level-1 Trauma Centers should be performed for patients requiring care unavailable in these hospitals (e.g., neurosurgery, cardiothoracic surgery, burn care, and pediatric intensive care). During larger incidents or during those happening within enclosed spaces (buildings and buses), there may be a greater need for secondary distribution.

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