

Moving Forward with Combat Casualty Care: the IDF-MC Strategic Force Buildup Plan “My Brother’s Keeper”

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“We succeed only as we identify in life, or in war, or in anything else, a single overriding objective, and make all other considerations bend to that one objective”

Dwight D. Eisenhower

Throughout modern history, military medicine, especially combat casualty care, has undergone substantial improvement and development. Indeed, the recent conflicts in Iraq and Afghanistan saw a dramatic reduction in battlefield mortality, as measured by the case fatality rate. The CFR, which is the number of deaths divided by the number injured, was less than 10% in these large-scale conflicts, an unprecedented achievement in the history of military medicine [1] especially considering the increased severity of injuries. This can be attributed to innovative treatment modalities, including effective measures for hemostasis at the point of injury and improved force protection [2]. Above all however, it was the result of a structured process that included concepts such as “eliminating preventable death” [3], recognizing the importance of forward surgical capabilities [4-6], conducting focused research and development, as well as engaging international collaboration. Although most of these concepts were recognized and developed during previous conflicts, it is their integration into a structured and goal-oriented casualty care system that led to the unprecedented survival rates.

The Israel Defense Force Medical Corps emerged from Israel’s last major military conflicts – the Second Lebanon War (2006) and Operation Cast Lead (2009) – with the feeling that medical care could be better optimized and adapted

for the modern battlefield [7]. These notions would form the cornerstone for the IDF-MC force buildup plan. While the overarching medical corps objectives were left unchanged, we set out to identify the path toward our goal of providing the best medical care for casualties, taking into account knowledge accumulated, lessons learned and the gaps identified over recent years.

By law, the IDF-MC is responsible for the health of all servicemen/women across all branches, whether draftees, military professionals or active duty reservists, during both peace and war. Recognizing combat medicine and casualty care as one of two of the IDF-MC’s cardinal efforts (alongside primary health care), the IDF-MC chose “My Brother’s Keeper” as the name for its 10 year force buildup plan, a quote also used in the oath sworn by all IDF medical providers [8].

The IDF-MC operates in an echelon-based system. The echelons are also referred to as Roles, where Role 1 is traditionally the medical care and evacuation means available at the level of the battalion while Role 2 is at the brigade level. Role 2 (intensive care) facilities augmented with emergency surgical and postoperative capabilities are often designated “2+” [9]. Because of the proximity of Israel’s civilian medical centers to the battlefronts, these centers may be incorporated relatively early into the chain of care provided to soldiers wounded in action; they thus function as both Role 3 (traditionally field hospitals) and Role 4 facilities (traditionally specialty hospitals). The IDF-MC can therefore focus on earlier echelons of care, with “My Brother’s Keeper” addressing primarily point-of-injury care, and Role 1 and Role 2 facilities.

In this article we describe the strategic process undertaken by the IDF-MC in developing its 10 year force buildup plan. We believe that this may serve as a model for achieving goal-oriented, strategic improvement across a structured medical system. We present the steps involved in creating the plan, as well as the consequent changes that occurred within the IDF-MC. A similar approach may be adopted not only for combat casualty care but throughout the entire range of trauma medicine. We

CFR = case fatality rate

IDF-MC = Israel Defense Force Medical Corps

conclude this manuscript by opening and encouraging discussion regarding new goals for the next decade.

STEP ONE: FORMING THE CONCEPTS AND SETTING THE BAR HIGH

Comparing the quality of care provided to disparate trauma casualties is challenging since different measures are used to evaluate such performance [10]. During war this challenge becomes even more complicated and may even be insurmountable. For example, the “fog of war,” poor data collection, differences in the scale of the conflict, extreme environmental conditions, and constant developments in weaponry, protective gear and techniques significantly limit our ability to make comparisons about the efficacy and quality of the medical care tendered [11]. One of the more commonly used measures, the CFR, was introduced in an attempt to meet this challenge. Using the CFR, we observe tremendous progress in combat casualty care over the last decade [12]. In contrast to CFRs of 14%–16% reported from the 1970s until 2008, the CFRs reported by NATO forces in Afghanistan are as low as single digits [3,7]. These impressive gains served as a basis for self-assessment by the IDF-MC.

Once a reduction in CFR was identified as a measurement of casualty care improvement, a systematic approach was required to create a working scheme. Aiming to deliver medical care to those who will benefit most, the concept of “preventable death” was adopted to describe casualties whose lives could have been saved. Unlike casualties whose injuries are too severe to be salvaged or whose injuries are non-lethal, “potentially salvageable” casualties’ lives could be saved by appropriate and timely medical care and evacuation [3]. While the concept is not new, it was not until a medical officer reported on the success of their efforts in eliminating preventable deaths in a special operations regiment that the concept became entrenched in combat casualty care [3]. This report posed a significant challenge to the leaders of medical systems across the military world. In the IDF-MC, we chose to raise the bar even higher and set our goal as eliminating preventable deaths not only across a specific regiment or division but across the entire IDF (all services and branches). The importance of injury prevention in reducing the number of non-salvageable injuries was also an integral part of the plan. For the most part, existing IDF-MC doctrine and principles were realigned to be made compatible with the widespread implementation of the concept across all echelons of care and through all branches of the IDF.

STEP TWO: FROM CONCEPTS TO DOCTRINE – FORMING THE PLAN

Once a measurable goal was identified, a stepwise, practical and tangible plan was constructed. While specific emphasis was previously placed on improving the clinical aspects of trauma medicine, it was clear that in order to achieve the goal of eliminating preventable death a comprehensive approach would be required, namely, joining the four elements of modern combat casualty care (trauma medicine, tactical medicine, evacuation,

injury prevention). The wounded combatant on the battlefield requires rapid and efficient medical care under fire as close as possible to the point of injury. Thus, any injury sustained during combat represents a significant tactical – as well as medical – challenge. Accordingly, the subsequent force buildup plan did not focus solely on trauma medicine but on the tactical aspects of combat casualty care and casualty evacuation critical for improving patient outcomes. Moreover, while the focus placed on causes of preventable death addressed approximately 25–30% of combat-related mortality, further reductions in mortality may be achieved by addressing injury prevention for injuries not currently amenable to medical care (e.g., severe head injury).

STEP THREE: FROM DOCTRINE TO ACTION – LAUNCHING THE PLAN

One of the most significant challenges was conveying the goal to senior line commanders. Line commanders focus on mission completion. Thus, while the non-medical leaders are ultimately responsible for the prehospital casualty response system [3], the importance of medical needs may be less intuitively perceived by them.

Bringing senior commanders in the IDF to adopt the goal of eliminating preventable death was crucial for the successful implementation of this plan. An open dialogue between senior medical leadership and senior line commanders facilitated the acceptance of this goal and its eventual incorporation into plans issued by the General Chief of Staff, and from there, throughout all services and units.

As mentioned earlier, the IDF operates in relative proximity to the civilian population, infrastructure and facilities. While cooperation between military and civilian systems has been part of combat casualty care in the IDF, the implementation of “My Brother’s Keeper” reinforced the importance of this collaboration. In conjunction with the endorsement by both IDF senior leadership and civilian health system leadership, resource allocation for implementation of the plan remained a significant obstacle. This was made even more challenging due to IDF budget constraints. These challenges notwithstanding, the IDF-MC worked to integrate the plan into the general force buildup plans of the IDF. Significant progress was made during Operation “Pillar of Defense” (November 2012), which provided an important catalyst for achieving implementation. This included procurement and distribution of advanced arterial tourniquets and protective eyewear, hemostatic dressings and freeze-dried plasma, among others. Unavoidable emerging conflicts as well as ongoing security missions would serve as platforms to demonstrate the feasibility and benefits of new equipment and doctrine.

International collaboration played an important role. Our international colleagues were involved in the construction of the force buildup plan and provided advice regarding products for procurement and the drafting of clinical guidelines. Extensive review of the Tactical Combat Casualty Care doc-

trine (including an IDF non-voting participant in the steering committee) helped the IDF-MC develop its own independent doctrine, assimilating some Tactical Combat Casualty Care concepts while leaving out others so that the doctrine would remain compatible with IDF-specific needs.

While significant changes were made across the combat care spectrum, for the most part existing IDF-MC principles were adapted and facilities and equipment reconfigured to be made compatible with widespread implementation across all echelons of care and through all branches of the IDF.

COMPONENTS OF “MY BROTHER’S KEEPER”

• **Trauma medicine**

Hemorrhage has been shown to be the most prevalent cause of preventable death (responsible for over 90% of those deaths), followed by airway obstruction and tension pneumothorax [12]. Preventing these deaths became the guiding principle for revising our doctrine, focusing our training and directing purchasing. Further data indicate that most trauma-related deaths occur soon after injury, often before the casualty’s arrival at a medical treatment facility [12]; this suggested that in order to produce the maximal effect, efforts should focus on “point-of-injury” care and “close to point-of-injury” care.

With hemorrhage identified as the primary cause of preventable death, improved means of treating compressible and extremity hemorrhage were acquired. Following the United States Army Institute of Surgical Research recommendations and after local testing, the Combat Application Tourniquet (also known as “C-A-T”; Composite Resources, Inc., Rock Hill, SC, USA) was chosen as the standard issue tourniquet. Under “My Brother’s Keeper,” its use was expanded to all combatants across all services (both active duty and reserves). The IDF chose Combat Gauze (Z-Medica, Wallingford, CT) as its preferred hemostatic dressing based on internal research in early 2006. The distribution of hemostatic dressings was expanded as well, so that it included basic medics in addition to advanced life-savers. Training was modified so that it focused on bleeding control at every level of provider, including self-treatment by all soldiers, and involved packing of non-tourniquet amenable wounds with hemostatic dressings by basic medics.

After addressing hemorrhage, the second leading cause of preventable death – airway obstruction – was targeted for improvement. Advanced airway management in the IDF, performed by either physicians or paramedics, includes orotracheal intubation as the first choice for definitive airway control, followed by cricothyroidotomy for unsuccessful intubation. Research conducted by the IDF-MC on airway interventions performed in the field by IDF advanced life-savers led to significant revisions and refinements in the IDF clinical practice guidelines [13].

The third major cause of preventable death, tension pneumothorax, was also addressed. Published data show that the

device used for needle chest decompression, a 14-gauge venous catheter, was inadequate in terms of length and diameter [14]. Accordingly, this catheter was replaced by the Vygon thoracic catheter (10 French, 8 cm, Vygon®, Norristown, PA, USA) which was originally designed as a neonatal chest tube. Although the Vygon catheter has been used sporadically in the IDF since 2006, it was the focus placed on causes of preventable death that led to this catheter’s widespread procurement and distribution. The Vygon catheter is currently the instrument of choice for temporary alleviation of tension pneumothorax. Clinical practice guidelines were updated accordingly.

In addition to addressing the above causes of preventable death, efforts were also directed toward restoring casualty physiology. With our focus directed toward the bleeding patient, remote (i.e., not in a standard medical care setting) damage control resuscitation served as a key concept [15,16]. Volume resuscitation and hypothermia prevention are preferably performed during evacuation but are often required at or near the point of injury while awaiting evacuation. Patient care according to RDCR principles requires a skilled provider equipped with the relevant tools. A special task force, organized by the IDF-MC and comprising the country’s leading trauma surgeons and hematologists, examined the full arena of advanced field RDCR in 2011 to determine future priorities. The board recommended the use of point-of-injury tranexamic acid; this was incorporated into IDF clinical practice guidelines for all advanced life-savers by mid-2011, and was further promulgated under “My Brother’s Keeper.” The second priority set by the task force was the use of plasma as soon as and as close (physically) as possible to the point of injury [17]. Innovating the way RDCR is performed, and in light of the task force recommendations, we took a three-pronged approach. First, we switched the 1 L bags of Lactated Ringers (in use for decades) with 500 ml bags, at all levels of medical providers, including basic medics. This change accompanied an updated fluid resuscitation protocol to help ensure that lower volumes of infusion are administered [18]. Second, the IDF pioneered the point-of-injury use of TXA (across all services and branches, active duty and reserves). TXA may be administered by every physician and paramedic in the IDF to casualties who meet specified criteria. This was later adopted by the national civilian emergency medical service (Magen David Adom) as well [19]. Third, plasma was identified as an improved pH-balanced resuscitation fluid that would not contribute to dilutional coagulopathy. For use in the field, the IDF introduced freeze-dried plasma (LyoPlas N - w, Deutsches Rotes Kreuz, German Red Cross, Blutspendedienst West, Germany) as the resuscitation fluid of choice for the severely wounded casualty in hemorrhagic shock. Stored at ambient temperature, with a proven safety record and suitable for all blood types, it has been car-

RDCR = remote damage control resuscitation
TXA = tranexamic acid

ried by IDF advanced life-savers since the beginning of 2013 and used to treat dozens of casualties to date [17,20].

Medical care provided in combat scenarios often involves limited treatment and evacuation capabilities. When combined with an austere environment, decision making is significantly impeded and patient triage mandates special attention. To assist with decision making in the field, pulse oximeters, and capnometry devices, once available only at the battalion level, were made available for all frontline advanced life-savers. Role 2 medical units were equipped with advanced monitoring capabilities, allowing medical care to approximate the care provided in hospital settings as closely as possible.

Improving the care provided in the early echelons of care will result in higher rates of more severely injured casualties reaching advanced medical facilities. Role 2 units were therefore augmented to allow for advanced patient care, specifically in scenarios requiring prolonged patient care due to delayed evacuations. In augmented role 2 units (2+), deployed trauma surgeons are sufficiently experienced and skilled to make better decisions and optimize high intensity casualty care according to RDCR principles, while reserving their surgical abilities for the few patients who truly require emergency, prehospital surgical intervention. This, in turn, required both equipment and personnel capabilities suitable for relevant medical as well as tactical scenarios.

• Tactical medicine and evacuation

While improving trauma care is a substantial step toward the goal of eliminating preventable death, the tactical aspects of combat medicine must also be addressed. Even the best available medical equipment in the hands of highly capable providers cannot be used to their full potential if not positioned at appropriate locations. Medical providers' comprehension of the tactical scenario is crucial, as tactical considerations guide the appropriate medical response and greatly influence casualty evacuation.

Mortality analysis in the IDF, as well as published data, reveal that most trauma-related deaths occur before arrival at an echelon 1 or higher medical treatment facility [7,12]. Accordingly, in order to maximize medical care and prevent mortality, medical care should be pushed forward, as soon and as close as possible to the point of injury ("time is life"). While the concepts of buddy care and tourniquet use at the point of injury have existed in the IDF for decades [21], advanced life-savers were traditionally assigned to a battalion or, in the case of Special Forces, to a squad. In light of the aforementioned analysis, advanced life-savers were incorporated at the company level as highly mobile medical squads. These squads are capable of reaching casualties within minutes of injury and performing bleeding control and other live-saving interventions.

At the higher echelons of care (from the brigade level), Role

2 medical capabilities, forward medical companies and forward surgical teams underwent several adaptations. It was clear that for a medical unit to be relevant it needs to be deployed in appropriate proximity to the fighting soldiers, and that large, unarmored, slow-moving units are not tactically relevant to the battlefield. FMCs and FSTs were thus joined, creating organic modular units capable of performing both critical care and RDCR, as well as damage control surgery, while retaining the surgical team's capability to mobilize and join other FMCs when necessary. Whereas these units once trained separately and deployed in three large tents, they now have joint training exercises and deploy in a single space, making for a much smaller and tactically relevant facility [22]. Medical equipment for these advanced units was also significantly upgraded, including procurement of equipment previously available only at civilian medical centers. These upgrades are in accordance with the IDF-MC's overarching goal, as preventable deaths may be eliminated by bringing advanced medical capabilities as forward and as close as possible to the point of injury.

Furthermore, the importance of rapid evacuation was reinforced, including the use of additional, designated evacuation assets and medical teams, and collaboration between the components that make up the evacuation chain was strengthened. The line commanders' support was crucial since they are ultimately responsible for casualty evacuation. Troop training for casualty evacuation was emphasized and adequate command and control was ensured for successful mission completion.

• Injury prevention

Benjamin Franklin famously said, "An ounce of prevention is worth a pound of cure," and this is as true today as it was nearly 300 years ago. Under "My Brother's Keeper," greater emphasis has been placed on more efficient implementation and further development of personal body armor as part of the strategic plan. Initial focus has been placed on eye protection, helmets, and torso protection.

Lethal injuries sustained by the brain are a major cause of what is currently regarded as non-preventable death [12]. As such, brain injury prevention is of prime importance. It was previously reported that lethal brain injuries are more common in the occipital and temporal areas [23]. We continue to move forward, along with IDF research and development teams, in our efforts to produce a durable, lightweight, bulletproof helmet (at least in the more sensitive regions) in order to minimize head injury fatalities while maintaining combatant mobility and comfort.

In the 2006 Second Lebanon War, the prevalence of eye injuries was 9% [7]. The American army documented that protective eye wear successfully reduces the rate and severity of ocular

FMC = forward medical company
FST = forward surgical team

injuries, and that intense educational steps improve compliance with the use of protective gear [24]. Ballistic eye protection almost eliminated eye injuries in military convoys, and it was realized that specialized eye protection elements should be implemented in the battlefield [25]. The IDF-MC has thus started to purchase and distribute open ballistic eye protection gear to every land combatant as early as the soldier recruitment phase. The shift to open protective ocular gear coupled with an educational program and guideline changes may lead to a considerably higher compliance rate (unpublished data).

IDF-MC physicians are well placed to work with material engineers and other scientists to help improve body armor, with special attention to protection of junctional areas such as the neck, armpit, and groin.

STEP FOUR: LEARNING AND TRAINING

The introduction of new medical doctrine, tactics and medical equipment mandated intensive training of medical personnel. Existing medical training facilities, as well as troop training while deployed to the various commands and branches, had to be utilized for new training modalities and new medical concepts. Other more sensitive medical capabilities, such as point-of-injury administration of freeze-dried plasma, required medical care providers to undergo a special training session [17]. Significant changes were made in combatants' first aid training, adjusting the training sessions to the causes of preventable death. The combat medic course, as well as advanced life-saver training, also underwent adjustments, placing similar focus on preventable death, as well as medical care provided in combat scenarios.

One of the main concepts in the buildup plan of "My Brother's Keeper" force is active involvement of line commanders. Thus, the notion of eliminating preventable death, as well as other key factors in tactical medicine, is becoming an integral part of all command training and educational programs in the IDF, starting with squad commanders, continuing through officers' training course, and up to the general staff level.

Ongoing data acquisition and analysis forms the basis for any changes implemented by the IDF-MC [7,13,18,19]. The IDF Trauma Registry is a database of all trauma casualties (civilian or military) treated by military medical teams since 1997. Data are gathered from medical providers in the form of casualty cards, which are followed by a more comprehensive after-action medical debriefing. Hospitalization data are collected directly from treating hospitals in the form of medical charts. All available information is then entered into the ITR at the Trauma and Combat Medicine Branch, at the Surgeon General's headquarters. While casualty cards remain in use, the ITR has undergone significant changes and currently allows direct online input of data by the treating

physician or paramedic. Data analysis is performed routinely, with more focused analyses when possible gaps are identified by medical providers in the field or during after-action debriefings and reports. Lessons learned from these data are used to fine-tune medical equipment, doctrine, and training.

Introducing a new plan into a complex medical system poses a considerable challenge in terms of the plan's assimilation and its acceptance by the different branches and arms. As part of the implementation of "My Brother's Keeper," a pre-planned survey was conducted one year after the plan's implementation. This survey included 475 IDF-MC responders across all branches and arms. The results of this survey demonstrated a relatively high penetration, with 65% of responders stating that they are familiar with the force buildup plan. Of the 65% who were familiar with the plan, 77% believed that its implementation would improve casualty care. As testament to the plan's penetration, when asked to describe in their own words the issues addressed by this plan, the majority of responders used the terms "life-savers" and "preventable death" – fundamental concepts of the plan. This widespread acceptance of new concepts by a large medical system helps demonstrate the successful incorporation of the "My Brother's Keeper" force buildup plan.

WHERE DO WE GO FROM HERE?

While significant advancements have been made in recent years, our work is far from finished. Casualty triage, one of the most crucial aspects in patient care, remains a major challenge. Despite significant developments in monitoring and assessment capabilities, there is no tool capable of providing early and accurate differentiation between casualties requiring immediate medical care and casualties whose care can be delayed [26]. The IDF-MC is engaged in ongoing research assessing novel techniques to help close this gap in accurate rapid triage [27,28]. With regard to hemorrhage, the trauma world's efforts are now turned towards management of non-compressible hemorrhage, using novel technological capabilities such as self-expanding materials injected into the abdominal cavity [29], applying low voltage high frequency electrical current to facilitate constriction of blood vessels [30] and inserting balloon catheters designed to obstruct the descending aorta [31], essentially transforming a non-compressible hemorrhage into a compressible hemorrhage. While the use of freeze-dried plasma at the point of injury is a big step forward in RDCR, other blood components or oxygen carriers that are field-deployable are currently out of our reach.

The challenge of rapid evacuation under hostile conditions remains a cornerstone in combat casualty care. One possible alternative, unmanned evacuation, might be a leap forward in casualty evacuation. As for personal protective gear, lighter and more durable materials will be specially designed to provide protection from current and future threats.

ITR = IDF Trauma Registry

While the IDF-MC strives to bring the best combat casualty care possible to the field, we hope that these efforts remain academic.

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