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# Self-Sufficient Healthcare Logistics Systems and Responsiveness: Ten Cases of Foreign Field Hospitals Deployed to Disaster Relief Supply Chains

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**ABSTRACT**: Recent disasters around the globe illustrate the unpredictability of their timing and the severity of their impact, making aid operations highly uncertain and complex. The aftermath of sudden-impact disasters, such as civil conflicts, wars, and natural disasters, are typically characterized by chaos and the urgent need for medical care for a massive number of casualties; however, damage to local healthcare infrastructures usually render them unable to deliver needed services. Foreign field hospitals, innovative self-sufficient emergency healthcare logistics systems deployed outside the hospitals' country, constitute a temporary solution until the local facilities are repaired or rebuilt. These types of healthcare logistics system have been deployed with great success. However, not much is known about factors that may account for their success in the supply chain literature. In this study, we investigate military foreign field hospitals and explore general factors that may account for their effectiveness. Specifically, we look into military healthcare logistics systems, specifically foreign field hospitals (FFHs), to explore factors that may account for their responsiveness. We examine ten successful deployments of an experienced and effective military FFH through an exploratory case analysis to shed light into factors that may account for its success. Various propositions and avenues for future research are developed.

***Keywords:*** *Flexibility, responsiveness, healthcare logistics, foreign field hospital, humanitarian aid.*

## 1. INTRODUCTION

The humanitarian aid efforts after a natural disaster can significantly diminish social impact and suffering (Tomasini & Wassenhove, 2009a), measured in terms of the loss of life and property. Logistical deficiencies of healthcare providers (DiAquoi, 2011; Herron & Smith, 2011; McClintock, 2009) following the tsunami in Asia in 2004, Hurricane Katrina in 2005, the earthquake in Haiti in 2010, the chain of disasters in Japan in 2011, and, most recently, the typhoon in the Philippines in 2013 have brought to public attention the need to establish effective humanitarian operations designed to be responsive to sudden-impact disasters. The source of disasters can vary to include events such as earthquakes, tsunami floods, typhoons, radioactive events, and humanitarian crises in war zones (Wassenhove, 2006). While disasters can impact developing countries the hardest, the recent tsunami-related disaster in Japan exemplifies the vulnerability of developed countries as well. This natural event, in addition, shows that the initial source of disaster can have a complex evolution (earthquake, tsunami, flood, and radiation).

Boin, Kelle, and Whybark (2010, p. 1) discuss the different challenges faced by humanitarian aid organizations and observe that "practitioners have enjoyed only limited help from academics." Understanding how humanitarian organizations design, implement, and manage their disaster relief efforts to deliver effective and efficient results will benefit the supply chain operations body of knowledge (Gatignon, Wassenhove, & Charles, 2010). One such little-known organization in the supply chain literature in general is the foreign field hospital (FFH). After a large-scale disaster, the immediate survival of the affected population is largely dependent on the quick response of healthcare systems within the critical first few days (Guha-Sapir & Panhuis, 2009). If the home-country healthcare services are unable to cope due to damage to hospitals, clinics, and facilities, or to lack of expertise, then international medical aid is essential. In such scenarios, the rapid deployment of foreign field hospitals can provide a temporary solution to save lives (Redwood-Campbell, 2011). A field hospital is an independent emergency healthcare facility which is deployed fast, typically in sudden-onset disasters, and represents an innovative and complex logistical system that involves rapid shipment of remedies, diagnostic equipment, nurses, physicians, interpreters, and the assembly of needed medical facilities amid the rubble.

Among successful examples is the FFH deployment of the International Federation of Red Cross and Red Crescent Societies (IFRC), based out of Oslo and owned by the Norwegian Red Cross, to Haiti after the 2010 earthquake (Elsharkawi et al., 2010). It had a 20-bed surgical facility with medical supplies, electrical generator, and sanitation, along with vehicles. The FFH was initially located in the main University hospital compound at Port Au Prince and started admitting patients four days after the earthquake. The outpatient ward treated about 75 patients daily. In addition, the Red Cross facility engaged in epidemic prevention measures. Another successful example is the Miller School of Medicine at the University of Miami Global Institute and the nonprofit organization Project Medishare (UMGI/PM), which established a FFH in Haiti. Due to their proximity to the disaster area, the first medical team of five people arrived only 20 hours after the earthquake (Ginzburg et al., 2010). Overall, 425 severely injured survivors were treated by the UMGI/PM field hospital during its first week of the relief operation.

As the examples suggest, FFHs have been successfully used in the aftermath of disasters; however, we know little about the factors that account for their performance from the supply chain literature. As such, we adopt an inductive grounded case study approach to explore structural design factors that may account for the effectiveness of such self-sufficient healthcare logistics systems. In this study, we investigate military foreign field hospitals, self-sufficient healthcare logistics systems aimed at providing emergency health services in disaster sites. Past literature suggests that responsiveness is critical in the aftermath environment of sudden-impact disasters (Guha-Sapit & Panhuis, 2009; Tomasini & Wassenhove, 2009b). Therefore, we look into a military healthcare logistics system (FFH) to explore potential design traits that fit the chaotic, complex, and uncertain environment of healthcare disaster relief (Drazin & Ven, 1985).

Specifically, we focus on a particular type of aid within the "humanitarian assistance" category (Byman, Lesser, Pirnie, Bernard, & Waxman, 2000): emergency health services. While there are many types of disasters (Day, Melnyk, Larson, Davis, & Whybark, 2012; Wassenhove, 2006) and response phases (Heaslip & Barber, 2014; Heaslip, Sharif, & Althonayan, 2012; Kovács & Spens, 2007), our primary focus is on sudden-onset disasters in general. The case data shows that a FFH achieves responsiveness by hav-

ing an organizational structure that confers it the required flexibility to fit the general characteristics of the aftermath of sudden-impact disasters. The rest of this study is organized as follows. First, we briefly discuss humanitarian operations, foreign field hospitals, and healthcare service responsiveness. Next, we elaborate on the methodology used, followed by the description of a series of ten case studies over three decades. We then propose a set of propositions. Finally, we conclude with the limitations and future research opportunities that can further develop this emerging field of study.

## 2. HUMANITARIAN OPERATIONS, HEALTHCARE DISASTER RESPONSIVENESS, AND FFHS

An area that has gained prominence in practice and research within disaster relief is the improvement of the management of humanitarian aid (Diaz & Tachizawa, 2015; Kovács & Spens, 2009). Humanitarian aid involves "the process and systems in mobilizing people, resources, skills and knowledge to help vulnerable people affected by disaster" (Wassenhove, 2006). Tomasini and Wassenhove (2009a) present three principles for disaster relief initiatives accepted by most of the humanitarian organizations: humanity, neutrality, and impartiality. The principles mean that the aid should be provided without discrimination to the people in need and without bias toward parties that could cause conflict in the suffering countries.

Tomasini and Wassenhove (2009b) characterize every humanitarian aid initiative as having ambiguous objectives, limited resources, high uncertainty, urgency, and a politicized environment. Balcik, Beamon, Krejci, Muramatsu, and Ramirez (2010) argue that the management of humanitarian aid is difficult, because different types of organizations are involved in the process, such as international and local humanitarian relief organizations, local governments, the military, and the private sector. Each of these organizations has different structures, capacities, and goals; thus, coordination among these disparate partners is an important challenge in the relief process (Stephenson & Schnitzer, 2006; Tatham & Kovács, 2010). Some of the difficulties in building an effective humanitarian aid network involve identifying the need and accessing the damaged area, the impact and level of influence of the aid, funding, political relations, and security of the aid force on site.

As the recent example provided by the disaster in Japan illustrates, the timing and level of impact suffered by areas in need of humanitarian aid pose high uncertainty and complexity. In that instance, a chain of natural disasters started with an 8.9 magnitude earthquake, which caused a tsunami responsible for damaging supposedly highly reliable nuclear facilities. As a result, an extensive area of the country was exposed to damage from radiation as well as structural failure from the earthquake and the corresponding tsunami. We see that, even though some geographical zones may be known for their vulnerability to natural disasters, their timing, complexity, and ensuing impact are difficult to predict. Importantly, the sources of sudden-onset disasters are not only natural events but also man-made (Wassenhove, 2006); however, independent of the sources, they are typified by the speed of onset. Therefore, a responsive logistical system is of critical importance. This performance characteristic fits Day et al.'s (2012) argument that disaster relief supply chains operate under conditions of extreme environmental uncertainty and dynamism.

In these scenarios of uncertainty and dynamism, the availability of emergency medical care in the aftermath is critical; however, damage to the local healthcare infrastructure usually renders it unable to deliver needed healthcare services. One solution to this problem is the dispatching of military foreign field hospitals as a temporary solution to address emergency medical needs until the affected country is able to rebuild and repair its healthcare facilities.

Byman et al. (2000) categorize military disaster relief supply chain operations missions into: a) humanitarian assistance, b) protection to humanitarian assistance, c) assistance to refugees and displaced persons, d) peace agreement enforcement, and e) restoring order. Within these categories, prior research indicates that the military has historically cooperated horizontally with relief agencies – that is, with other organizations at the same level within the disaster relief supply chain – by coordinating airlifts, sharing storage facilities, providing logistics assets, providing information on infrastructure and security, and setting up communications networks (Balcik et al., 2010). Correspondingly, the literature identifies the key military missions as establishing a secure environment and aiding relief organizations, a mission that is fulfilled by providing assets and capabilities and creating conditions to permit the return of the disaster area to normality (Barber,

2012; Cross, 2014; Heaslip & Barber, 2014; Rietjens, Voordijk, & Boer, 2007).

In this study, we focus on a particular type of aid within the humanitarian assistance category (Byman et al., 2000): emergency health services. While there are many types of disasters (Day et al., 2012; Kovács & Spens, 2007; Wassenhove, 2006) and response phases (Heaslip & Barber, 2014; Heaslip et al., 2012; Kovács & Spens, 2011), our primary focus is on sudden-onset disasters in general. We examine a military healthcare logistics system to explore potential structural design factors that fit the chaotic, complex, dynamic, and turbulent environment of healthcare disaster relief (Balcik et al., 2010; Day et al., 2012; Drazin & Ven, 1985). These organizational environment characteristics are contingencies or threats that typify the highly uncertain environment of sudden-onset disasters in general (Day et al., 2012).

A FFH is an independent healthcare facility, which is deployed rapidly for emergency purposes, following the request of the affected country (World Health Organization/Pan-American Health Organization [WHO/PAHO], 2003. The WHO/PAHO (2003) defines a field hospital as "a mobile, self-contained, self-sufficient healthcare facility capable of rapid deployment and expansion or contraction to meet emergency requirement for a specified period of time." In actuality, we can approach a foreign field hospital as a self-sufficient emergency healthcare logistics system rapidly deployed upon the request of a country submitted to sudden-impact disaster. The effectiveness of such logistics systems hinges on their responsiveness to areas in which a disaster has compromised the delivery of healthcare services (Besiou, Stapleton, & Wassenhove, 2011; Day et al., 2012; Guha-Sapit & Panhuis, 2009; Tomasini & Wassenhove, 2009b).

Building on the theoretical insights and conceptual development from Bernardes and Hanna (2009), in this study, we define healthcare disaster responsiveness as the ability of a self-sufficient healthcare logistics system, such as a military foreign field service, to address current or emerging healthcare needs of an affected area in the aftermath of a disaster. The healthcare needs can demand that the logistics system varies its state to accommodate changes in the demand levels for services (e.g., number of casualties), service mix (e.g., level of primary and secondary care), demand for new services (e.g., from basic wards to infectious disease wards), and service delivery schemes (e.g., to war zones, conflict areas, neutral areas, underdeveloped regions, etc.).

## 3. RESEARCH DESIGN AND CASES

We selected a qualitative research design, and a case study approach, because in emerging research phenomena, like humanitarian aid operations, a qualitative approach not only can generate new theoretical ideas but also allow us to "examine a contemporary phenomenon in its real-time context" (Yin, 2013). Our review of extant literature on management in humanitarian aid shows the use of a case-based approach to understand field-vehicle fleet management operations (Martinez, Stapleton, & Wassenhove, 2011), humanitarian logistics (Tomasini & Wassenhove, 2009b), and management of supply chains in humanitarian logistics (Wassenhove, 2006).

Following Eisenhardt (1989) and Miles, Huberman and Saldana (2013), we adopt an inductively grounded case study approach to fulfill the important exploratory quest of better understanding how a little-known organizational structure (a FFH) achieves success (responsiveness) in a critical and complex environment (aftermath of a sudden-impact disaster). According to Miles et al. (2013), a highly inductive study design is appropriate when experienced researchers are exploring an understudied phenomenon, such as the use of a FFH in disaster relief and the organizational characteristics that confer it responsiveness in a chaotic, complex, and uncertain environment.

Our research design is based on multiple cases and involves multiple investigators; thus, allowing for replication logic (Yin, 2013), where the cases can be somewhat treated as "a series of independent experiments that confirm or disconfirm emerging conceptual insights" (Brown & Eisenhardt, 1997, p. 227). Studies following a similar research design identify the development of testable theory that reduces researcher bias and gives a close correspondence between theory and data as two salient features of replication logic (Amit & Zott, 2001; Ravenswood, 2011). Since the research on the topic of humanitarian operations is in the early stages and an in-depth understanding of the subject is considered urgent and necessary (Day et al., 2012), an inductive case study approach is a good research strategy (Edmonson & McManus, 2007; Creswell, 2012).

Our purposeful sampling involves the ten FFH deployments of the Israel Defense Forces (IDF) in the

last three decades (see Appendix I), which allow for different perspectives on the deployment of these self-sufficient healthcare logistics system to different areas of operation – purposeful maximal sampling (Cresswell, 2012). The selection of the IDF missions to investigate factors that may account for the success of FFHs is based on access and traits of the cases. We gained access to high-ranking and experienced officials directly involved with the deployments over the years. This allows our study to benefit from data provided by experience of over three decades in providing humanitarian healthcare aid at disasters areas. In addition, both the military strength and expenditure as a percentage of gross domestic product position the Israeli military within the top group of countries that typically deploy FFHs (Central Intelligence Agency, 2016).

After each mission, the IDF held a rigorous post-mission comprehensive investigation, in order to derive lessons about functional and structural adaptation, manpower selection and training, medical equipment and general facilities, transportation, communication systems, medical data storage, creativity, mission termination, etc. As such, a body of knowledge has been accumulated over the years by the IDF Medical Corps from deploying numerous relief missions to both natural and man-made disasters, in different regions of the globe (Africa, Asia, Caribbean, Europe, and Middle East). Access to this type of data, which juxtaposes different humanitarian missions, is regarded as helpful for the purposes of our study. Indeed our study shows an evolutionary pattern with improvements implemented from one mission to the next.

We collected primary data through interviews and secondary data through consultation to documents available on the missions. We conducted a series of interviews with several high-ranking career officials who led IDF missions over the years and have vast experience in humanitarian aid from their service in the Pikud Oref (Israel Home Front Command). Most of them are high-ranked officers in the IDF who served as the Chief Medical Officers of the missions described in the cases. We triangulated the primary data with secondary data published on the missions and other documents, conducting within and across-case analysis to identify patterns. Due to the nature of the organization and the sensitivity of its missions, names are not disclosed to preserve anonymity, but Appendix 3 presents general information on the interviewees. Appendix 4 describes the interview questionnaire protocol.

The summary of the cases in Appendix 1 illustrates the rapid tempo of the IDF FFHs, typically operational within 24 hours of deployment, and the range of services provided, which vary from primary care to advanced surgical and medical services. As these humanitarian aid missions take place across the globe, these type of healthcare logistic system faces operations in different cultures. The cases illustrate the need for healthcare services responsiveness even in terms of cultural diversity and provide examples of actions in this respect, such as the accommodation of Indian or Arabic traditions. The scale of the healthcare logistics system also responds to the dimensions of the impact and needs of the area affected, varying from small outpatient clinics to inpatient hospital structures. Appendix 2 shows the range of types of disasters, the duration of deployments, and the capacity of the logistic systems in terms of number of beds, personnel, and specialty areas. Each type of disaster is unique and imposes a different set of challenges and needs that reveal the paramount role of disaster responsiveness, which is achieved through various types of flexibility.

## 4. CASE ANALYSIS AND PROPOSITIONS

We performed our interpretation of the data in light of the main general precepts of the contingency theory. The contingency theory (Drazin & Ven, 1985; Lawrence & Lorsch, 1967) asserts that organizational characteristics should fit their environment in order to achieve high performance. Several studies in the literature build on the contingency theory to explain the relationship between the environment, organizational structure, management practices, and performance (Strasser, 1983). In the context of humanitarian aid, a foreign field hospital is a self-sufficient healthcare logistics system that requires structural flexibility to be responsive (Bernardes & Hanna, 2009) and, as such, to fit the highly uncertain and complex external environment that is the aftermath of sudden-impact disasters (Besiou et al., 2011).

One of the insights that emerges from our interviews and data analysis refers to organizational knowledge accumulated and diffused over the years by the IDF. This seems to have facilitated the identification and development of processes and capabilities that contributed towards the flexibility of the self-contained healthcare logistics systems. The evolution of IDF humanitarian operations started with

the deployment of mobile clinics to disaster areas (Kasis et al., 2001). This initial arrangement was later transformed into full-blown foreign field hospitals with their scale tailored to the type of disaster and area needs (echelons). The founder of the emergency medicine discipline in Israel, and a senior IDF Officer in charge of the humanitarian missions during the 1980s and 1990s [#4, appendix 3], describes the evolution and explains how it took place:

> *The first full-scale IDF FFH was in Armenia and later Turkey, India, and Haiti. The evolution happened in terms of four factors: structure, mode of operations, deployment, and assessment. The concept of the Israeli FFH is built based on the model of FFHs that were being used by the IDF during war times in the Middle East, such as the Yom Kippur War (1973) and Operation Peace Galilee (1982).*

The IDF FFH adopted the IDF military model of treating soldiers wounded in the battlefield using the medical principle of echelons, which refers to roles or levels of medical care. Echelons describe the stratification of the tiers in which medical care is organized to conduct treatment and is defined on the basis of capabilities and resources that they possess (Church, 1990). Following this principle, the IDF organizes the FHH in the first echelon (capable of triage in the field), second echelon (capable of functioning as a referral center providing secondary care), and third echelon (capable of performing evacuation for tertiary care). This allows the field hospital to prioritize patients based on the initial assessment of the severity of their injuries by the lower echelon. During the evolution of the humanitarian missions and development of the self-contained healthcare logistics system currently adopted by the IDF, there has been a great deal of learning and initiatives geared towards preserving such knowledge. A senior IDF Officer [#6, appendix 3] in charge of the humanitarian missions during the last decade elaborates on this point and highlights some important features of the process:

The Israeli government has been investing in costly humanitarian outreach around the globe for over three decades. The staff of every Israeli FFH is composed two-thirds of participants from past missions and one-third of newcomers, in order to transfer knowledge gathered between missions and create an organizational body of knowledge on humanitarian aid.

In addition to the procedural rotation of personnel, there are formal processes in place to codify and derive lessons learned. Another senior Officer [#4, appendix 3] indicates that the IDF humanitarian missions "conclude with a rigorous process of post-mission comprehensive investigation in order to derive lessons about what type of equipment to bring, how to airlift it, and where to unload it." He further states that "[a] body of knowledge was accumulated over the years by IDF from deploying in numerous relief missions." Such practices seem to assure the creation, transfer, and preservation of organizational knowledge, which, ultimately, seems to reflect on the identification and development of the capabilities that contribute towards the responsiveness of this type of self-contained healthcare logistics system. Therefore, the development, preservation, and transfer of organizational knowledge about humanitarian logistics may ascertain the fit between the FHH structure and the uncertainty and complexity of sudden-impact disasters.

**Proposition 1:** Healthcare logistics systems that over time systematically develop and codify humanitarian logistic operations knowledge are associated with higher responsiveness.

Civilian and military foreign field hospitals are self-contained healthcare logistics systems that have been used successfully in both natural and complex disasters, such as civil conflicts and wars. However, emerging from our data analysis is the notion that the military structure may confer advantages to these mobile healthcare logistical systems. One of the aspects raised by a senior Officer [#5, appendix 3] is the selection and training of staff that in the IDF "are selected to join the FFH missions, unlike some other countries' teams, which are based on volunteers." In the IDF FFH, the staff (physicians, nurses, etc.) is recruited in a very selective process. Only senior people that are highly ranked and very qualified are recruited after rigorous training in emergency medicine. The senior IDF Officer [#6, appendix 3] further elaborates on the selection and training for humanitarian missions:

> *The Israeli staff trains as a unified military unit for upcoming missions. Training is important because of the uncertainty in the situation. For example, in a disaster area the staff should know who they are supposed to treat and who not: it is an ethical dilemma to prioritize patients. In Israel, the FFH is composed of reservist soldiers drafted for the mission. The army takes care*

> *of their salary, medical insurance, and family while they are deployed overseas.*

This suggests that the military structure facilitates preparedness for humanitarian operations through formal training and the selection process. Another senior Officer [#5, appendix 3] states that the "advantage of military compared to non-profit organizations is that it has an annual budget to conduct practices." Yet another ranking official [#1, appendix 3] interviewed elaborates on other points:

> *The military gives structure and discipline. It recruits people in an organized manner, covers their life insurance to risky disaster areas, and pays their salary during missions. Because the military takes care of the twofold financial compensation and life insurance, staff can fully concentrate on accomplishing the relief mission. The military arranges life insurance for its staff, which is considered a critical factor by candidates for deployment in dangerous disaster zones.*

The system of benefits, training, and selection employed by the IDF seems very conducive to rapid deployment of mobile healthcare logistics systems. It allows the assembly of a highly trained and cohesive team suited to the situation and familiar with the processes in a short period of time. There are some unique characteristics to the case in that Israel is a small country; therefore, as a senior IDF Officer explains [#4, appendix 3], team members typically know each other, because "they studied in the same medical school, worked together, or live in proximity." While there are some nuances that may be unique to Israel, in general, the data seems to suggest that the military structure in terms of recruitment, training, and benefits may facilitate the fit between military FFHs and the uncertainty and complexity caused by sudden-impact disasters.

**Proposition 2a:** Formal recruitment, training and benefit packages have a positive effect on health services disaster responsiveness.

**Proposition 2b:** The underlying personnel benefits structure of a military healthcare logistics system are associated with higher health services disaster responsiveness.

We noticed in our cross-case analyses that the IDF staff has knowledge of culture, language, and the health situation of the country affected. After a disaster, it is paramount that field hospitals arrive on site and become operational between 36 and 72 hours in order to minimize the number of casualties. The location of the FFH is a strategic decision determined by military logistics considerations. The site is designed to survive aftershocks of earthquakes, and it needs to be located in a safe place if within a war zone, but at the same time, it needs to be accessible to patients. In addition, as the aftermath unfolds, the situation and needs may change.

During the field operations, there is the continuous need for air support to transport medicine and equipment. According to an official [#5, appendix 3], the military can provide "logistical support in the form of a self-sufficient supply chain of remedies, equipment, food, and water that civilian or non-profit humanitarian organizations lack the financial means to acquire." However, one key point that emerges in terms of healthcare services responsiveness across the cases is the ability to rapidly deploy with incomplete information. The IDF mission Chief Medical Officer to Armenia and Rwanda elaborates [#4, appendix 3]:

> *A uniqueness of Israeli FFHs is the ability for early arrival of the team after preliminary assessment with incomplete information. This logistical flexibility stems from the usage of military airplanes which are prepared in stand-by mode all-year around, ready for immediate call to be deployed. Military personnel can be drafted in short notice by command. Another logistical advantage, military equipment is accessible for usage, such as electric generators, laundry machines, remedies, food, tents, water, and kitchen supply, and soldiers are allocated as guards too in order to ensure security of the staff and equipment during a mission in a chaotic, uncertain environment.*

In this regard, another high-ranking official [#1, appendix 3] indicates that the "military has advanced communications systems, logistical support, and ability for rapid deployment by airplanes." The IDF Chief Medical Officer for recent missions to the Philippines, Japan, and Haiti [#6, appendix 3] shares a similar view about the military's ability for quick deployment on short notice:

> *Responsiveness, the ability to reach the disaster zone rapidly in two to three days maximum, is the major advantage of a military unit drafted to serve in the FFH by military authorization command. The FFH is equipped with advanced*

> *diagnosis equipment like X-ray and radiology machines from the military inventory that civilian organizations usually cannot afford. The IDF FFH is a self-sufficient facility with fuel, water, and food supplies.*

In Adapazari, Turkey (see Appendix I), after the earthquake in 1999, the availability of air transport for patients in more critical conditions to more appropriate hospitals, for example, the Istanbul hospital, helped the IDF FFH extend better quality of care to more patients. In general, the data seems to suggest that the access to dedicated and specialized equipment may facilitate the fit between military FFHs and rapid deployment required by the uncertainty and complexity caused by sudden-impact disasters.

**Proposition 3a:** Ready and formal access to dedicated supporting equipment have a positive effect on healthcare services responsiveness.

**Proposition 3b:** The underlying dedicated equipment structure of military healthcare logistics systems is associated with higher health services disaster responsiveness.

Another interesting theme that emerges from the data analysis related to health services disaster responsiveness is the ability to cooperate and integrate work with other agencies and organizations. For instance, in Armenia, the IDF invited the medical staff from the local hospitals destroyed during the earthquake to join its field hospital. This collaboration increased the capacity of the healthcare logistics system and added knowledge about the medical history of the region to the efforts. Similarly, in Rwanda, the IDF coordinated efforts with the local authorities for the site selection. The initial primary hospital gradually moved towards a secondary medical center and incorporated local and Dutch Army staff to support the expansion of the services. A high-ranking Officer sheds further light on this aspect [#2, appendix 3]:

> *In almost every mission, there were partnerships with other countries. In Rwanda, Kosovo, and Haiti, there was partnership with the USA, France, Germany, and local organizations. The Israeli FFH structural flexibility is demonstrated by the fact it can cooperate with other FFHs sent by different countries and with the local healthcare system. To enable this cooperation, interpreters are part of the staff.*

In Kosovo, the IDF partnered with young Albanian students that volunteered to provide translation in order to help the hospital. The IDF also coordinated with the local hospitals to transfer a few of the patients after initial triage. Another instance of cooperation and partnership took place in Haiti, where the Israeli field hospital reached maximum capacity in a couple of days. IDF officials coordinated with primary hospitals for the provision of postoperative care. This cooperation enabled the IDF FFH to provide more specialized and surgical services, knowing that patients would receive postoperative care in other facilities. In addition, another high official [#5, appendix 3] reveals that the Israeli FFH further cooperated with other countries in other ways, "sharing medical equipment and coordinating the transfer of patients between medical facilities."

In the Philippines, the IDF FFH combined its physical setup with the local structure and supported the local medical staff to create one integrated medical infrastructure. Although the visiting disaster relief group had 25 physicians representing most medical subspecialties and first-class logistics support, it relinquished sole decision-making authority and improvised to establish a model of cooperation with the local healthcare administrators. Open discussions to establish clear lines of responsibility and co-sharing of tasks helped the foreign medical team to gain the trust of the local facility and enabled smoother disaster operations. The cooperative arrangement allowed the Israeli team to provide medical assistance to 2,686 cases in ten days. In general, the data seems to suggest that the ability to cooperate, coordinate, and incorporate or become part of another team may facilitate the fit between the military FFH structure and the high uncertainty, evolving needs, and complexity caused by sudden-impact disasters.

**Proposition 4a:** Flexible integration and coordination capabilities have a positive effect on health services disaster responsiveness.

**Proposition 4b:** The multi-agency experience of the military healthcare logistics system provides flexibility that is associated with higher health services disaster responsiveness.

Another aspect that emerges from the cases and data analysis that seems to confer healthcare responsiveness refers to something akin to modularity and postponement of the healthcare logistical package. The data suggests that the IDF FFH can be partly or fully deployed and substitute or complement the local healthcare system. It can be designed for different stages of disaster: the first 48 hours for emer-

gency medical response – the immediate response phase in the disaster management cycle (Heaslip & Barber, 2014) – or three to fifteen days after the disaster for follow-up care and routine medical care based on the air travel distance from Israel to the disaster location. Asked about this aspect, a high-ranking Officer [#1, appendix 3] further elaborates:

> *The IDF FFH has a flexible structure to be adaptable to the magnitude and type of the disaster. It can be deployed in versatile modes of operation: primary care (first-aid clinic) or secondary care (with advanced surgery wards such as neonatal intensive care unit, etc.). For example, in Rwanda and Kosovo, the FFH was operated in primary care mode for first-aid treatment and minor surgeries only.*

The data seems to suggest an underlying ability to incorporate different capabilities by combining modules of personnel and equipment according to the current or emerging needs in the field. For instance, a physician who volunteered in Haiti [#3, appendix 3] discusses the flexibility of the healthcare logistics package:

> *It is dynamic according to emerging needs in the disaster area. In the beginning, it is a triage facility, and if there isn't enough space in the FFH for the hospitalization of patients, then new space is opened with tents made of net. For example, the Israeli medical team did outreach visits to treat patients in remote sites if they could not reach the FFH due to lack of transportation. Wards are created according to need in the field. Of course, there are basic wards that always exist like surgery, trauma, etc., but based on the need in the field a new ward maybe created. For example, a ward to deal with infectious disease.*

The Chief Medical Officer for recent missions to Japan, Haiti and the Philippines [#6, appendix 3] indicates that the FFH is able to adapt the operations, the structure, and the functions according to the emergent needs in the area of disaster. For example, he cites that, in Haiti, initially the team treated people suffering from crash injuries as a result of the earthquake, but after a month they started treating people for cholera. The data indicates that the FFHs combine the different resources to fit the situation in the area of disaster. The structure "can be deployed full scale with many wards like in the case of Haiti or it can be a mobile clinic like Japan", as indicated by one of our respondents. In Adapazari, Turkey, after the earthquake, it was important for the field hospital to be able to adapt to the situation as the medical needs changed. During the first few days, most of the patients were injured directly as a result of the earthquake and there was a need for surgical, orthopedic, obstetric, and gynecology treatment; in the later stages of the disaster effort, the hospital had to be able to provide regular medical care and also deal with infectious diseases. The combination of medical staff in the field hospital was designed efficiently to answer the medical needs based on all the stages after the earthquake. In general, the data seems to suggest that the capability to mix and match modules of personnel and equipment and to adapt in the area of operations facilitates the fit between military FFHs and the uncertainty and complexity caused by sudden-impact disasters.

**Proposition 5a:** The ability to rapidly reconfigure structure has a positive effect on healthcare services disaster responsiveness.

**Proposition 5b:** The underlying multidisciplinary logistical structure of military healthcare logistics systems is associated with higher health services disaster responsiveness.

The data analysis reveals another aspect that seems to confer healthcare responsiveness in disaster situations, which is the creativity and ingenuity of the personnel involved and their ability to accomplish the mission with limited resources. Both of these traits seem to provide flexibility to allow adaptation to situations of high uncertainty and disruption, such as encountered in the aftermath of sudden-impact disasters. The role of those factors was identified in the cases and became apparent during the interviews. For instance, an IDF Officer who volunteered in Haiti [#3, appendix 3] provides an illustration:

> *It should be noted that the medical staff in Israel is creative in improvising solutions under field conditions – which is exactly the characteristic needed in an uncertain environment post-disaster. It may be that the condition in Israel in which the staff is regularly working in hospitals with a lack of resources makes people creative.*

Another high-ranking official further elaborates [#4, appendix 3], indicating that in Israel: "Due to national security instability and shortage of natural resources, people in general attempt to creatively maximize output with limited capacity and to adapt to difficult situations; being able to operate under these condi-

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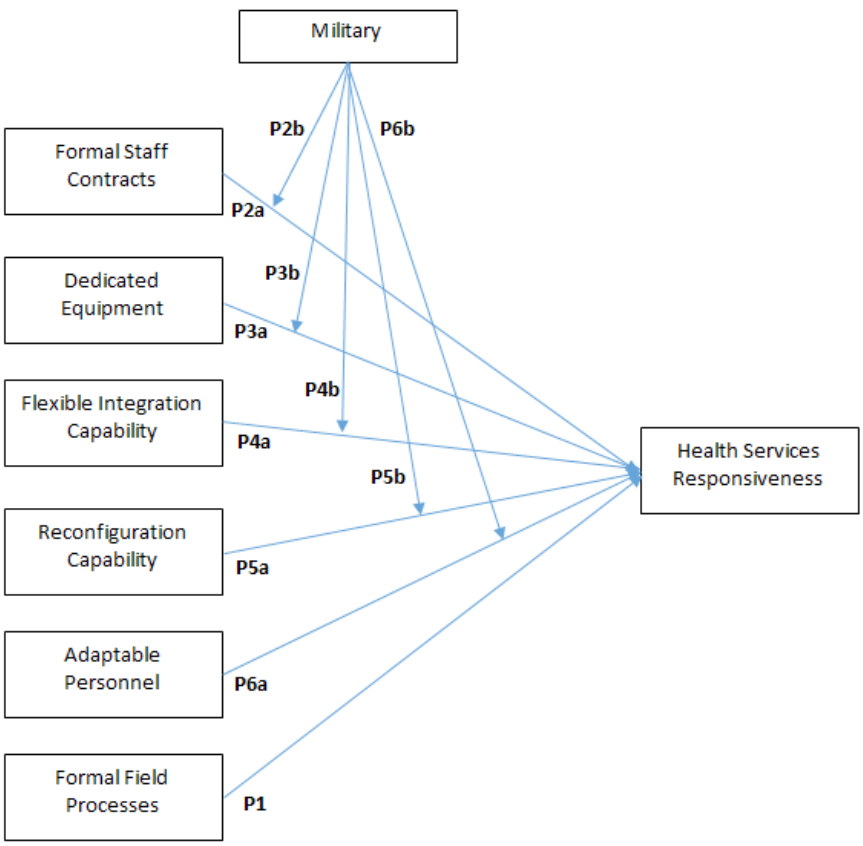
tions makes IDF FFH staff efficient in uncertainty post-disaster situations." In addition to these local characteristics, there is the general problem-solving attitude that typically characterizes the military operations and environment in general. Yet another high-ranking Officer [#1, appendix 3] adds that IDF FHH personnel bring prior military field experience, such as: "the ability to adapt to situations involving operations in uncharted terrain, the ability to improvise sleeping quarters outdoors, etc., which fits the post-disaster context." Once again, while there are some nuances that may be unique to Israel, in general, the data seems to suggest that military training and experience contribute towards personnel adaptability, making the military flexible and able to cope with limited resources, and may facilitate the fit between military FFHs and the uncertainty and complexity caused by sudden-impact disasters.

**Proposition 6a:** Creative and adaptable personnel has a positive effect on healthcare services disaster responsiveness.

**Proposition 6b:** The training and field experience of military healthcare logistics system personnel are associated with higher healthcare services disaster responsiveness.

There are other factors that may contribute to military FFH greater healthcare responsiveness as compared to volunteer civilian organizations, such as the chain-of-command and the juridical regulations that prescribe and enforce it. We also note that, according to a physician [#7, appendix 3], "hospitals in Israel are understaffed and under-budgeted. Consequently, medical staff has got used to working under pressure, long shifts, and filling multiple roles in rotation. All these characteristics are typical to what they might face in a disaster area." In addition, the IDF medical staff rotates between tasks and operates under constant pressure, which may also relate to higher levels of emergency healthcare responsiveness. Figure 1 summarizes the overall propositions.

**Figure 1. Summary of the propositions**



## 5. DISCUSSION AND GENERAL TAKE AWAY

Our study adds to a growing stream of research investigating humanitarian healthcare logistic operations. We contribute to this literature by shedding light on how a very effective and experienced humanitarian organization designs, implements, and manages its disaster relief efforts, addressing past calls for studies in this area (e.g., Gatignon, Wassenhove, & Charles, 2010). We accomplish this by examining the ten deployments of the IDF FFH in the last three decades and proposing factors that may account for their operational success.

Extant literature points out the important role frequently performed by military forces during sudden-impact disasters, such as civil conflicts, wars, and natural disasters (Apte, 2010; Heaslip, 2011; Heaslip et al., 2012). This literature asserts that the prominent role of the military in disaster relief efforts stems, at least partially, from its strength in logistical and organizational structure (Bjørnstad, 2011; Johnsen, Howard, & Miemczyk, 2009; Pettit & Beresford, 2005). Our study contributes to this stream a nuanced view of a particular military logistics system, the FFH, and particular design factors that may account for its effectiveness. Specifically, the results of our exploratory case analysis pinpoint categories of structural factors that may contribute to the responsiveness of this little-known healthcare logistics system in the supply chain management literature. The results from this study suggest that military FFHs are versatile and can be employed in the aftermath of both sudden-onset natural and man-made disasters and conflicts.

Past research separates the disaster management cycle (DRC) into different phases: preparedness, response, and recovery (Heaslip & Barber, 2014). While we did not set out to investigate activities that take place in each of the different phases as our primary goal in this study, we argue that the organizational knowledge codified and diffused over time, which we propose contribute to the identification of processes and capabilities that confer structural flexibility and support responsiveness, inform the preparedness phase (Heaslip & Barber, 2014; Kovács & Spens, 2007; Pettit & Beresford, 2009). Among specific activities that can contribute knowledge to that phase are the rotation of personnel and comprehensive processes of post-mission investigation observed in the deployments we examined.

In terms of the immediate response phase of the DRC (Heaslip & Barber, 2014), the critical point in terms of logistical support (Akhtar, Marr, & Garnevska, 2012), we observe that the IDF FFH adopts the medical principle of echelons, which refers to roles or levels of medical care. The IDF organizes the FFH in the first echelon (capable of triage in the field), second echelon (capable of functioning as a referral center providing secondary care), and third echelon (capable of performing evacuation for tertiary care). This allows the field hospital to prioritize patients based on the initial assessment of the severity of their injuries by the lower echelon. This organizational design is akin to and matches Heaslip and Barber's (2014) observation that the scale of logistical support may be linked to the scope of the disaster. The echelons describe the stratification of the tiers in which medical care is organized to conduct treatment. We note that each echelon of the FFH possesses a defined level of capabilities and resources that confers flexibility to the overall structure and supports responsiveness to the situation on the ground.

While prior literature advances our knowledge by categorizing the disaster management cycle into preparedness, immediate response, and reconstruction (Heaslip & Barber, 2014), the case analysis suggests that this useful categorization can be further expanded or discriminating in the case of relief health services. As illustrated by some deployments, such as Haiti and the Philippines, the immediate response phase may unfold in unpredictable ways and demand additional services not directly tied up to the initial event but to its contextual development. For instance, emergency services targeted towards crash injuries in the aftermath of an earthquake may need to adapt to accommodate the demand to contain contagious diseases at a later time. This suggests that the needs during the immediate response phase can evolve in complex ways, requiring an organizational structure of the logistics system that is flexible and can respond to emergent changes. It also suggests that it might be beneficial to sub-categorize the response phase into immediate and evolving stages to better examine the disaster relief supply chain processes.

Among the propositions contributed by our study towards better understanding of healthcare logistics system responsiveness are integration and coordination. Balcik et al. (2010) examine the basic structure of humanitarian relief chains and coordination mechanisms practiced at different stages. In general, our findings seem to concur that the ability to cooperate, coordinate, and incorporate or become part of another team may facilitate the fit between the mili-

tary FFH structure and the high uncertainty, evolving needs, and complexity caused by sudden-impact disasters. The effectiveness of such ability should confer flexibility to the healthcare logistics system and support its responsiveness. One key action we identify in this self-contained logistics system is the ability and willingness to hold open discussions to establish clear lines of responsibility and relinquish leadership when needed. This is a critical insight, as past research indicates that the coordination between military and relief partners is frequently problematic (Heaslip, Mangan, & Lalwani, 2007; Heaslip et al., 2012; Pettit & Beresford, 2005).

While each location and type of disaster presents unique challenges, we identify some general insights from our analysis that seem associated to the responsive characteristic of healthcare relief logistics systems. First, from a logistical perspective, the cross-case analysis suggests that the rapid dispatch of a preliminary team immediately after a disaster to gather tactical information can increase the responsiveness of the actual logistical system deployed. The information gathered by the preliminary team can inform the assembly of the modules of personnel and equipment that need to be brought together to provide the required capabilities of the healthcare logistical package. While the preliminary team collects information, the healthcare logistical package is assembled. This can allow the delayed customization of the available resources to the unique conditions of the aftermath and the specific emergency needs of the area affected.

Another insight is that the medical staff should be trained in a variety of wards since the uncertainty and complexity of these environments (Besiou et al., 2011) require flexibility. Team members are likely to rotate between tasks due to the shortage of staff and unpredictability of the situations. For instance, IDF surgical physicians assisted in routine patient care in Turkey, while non-surgical staff treated injured patients in Haiti. As such, it seems that cross-training increases flexibility to the logistical package and supports healthcare responsiveness in aid missions.

Third, creativity and problem-solving orientation seem to be necessary traits to deal with the complexity and uncertainty of disaster relief situations and to improvise logistical solutions also in the case of health emergency services. For instance, such traits can help accommodate difficulties in the field, such as shortage of basic surgical instruments as well as the supply of medical devices and advanced blood laboratory services. This is another personnel-related trait that supports or adds various characteristics of flexibility to the logistical package. Ultimately, this trait of the healthcare professionals supports healthcare responsiveness.

Finally, we note from the onset that the timing, complexity, uncertainty and the ensuing consequences of sudden-impact disasters demand a logistical system that fits those contingencies. We identify responsiveness (Bernardes & Hanna, 2009), more specifically healthcare disaster responsiveness, as the critical operational capability to address those contingencies. Our study advances propositions about characteristics of a self-sufficient emergency health system that fits the sudden-impact disaster environment, such as to deliver healthcare disaster responsiveness. These characteristics confer the logistics system the ability to vary its state to accommodate changes in the demand levels for services (e.g., number of casualties), service mix (e.g., level of primary and secondary care), demand for new services (e.g., from basic wards to infectious disease wards), and service delivery schemes (e.g., to war zones, conflict areas, neutral areas, etc.). Table 1 summarizes the general insights emerging from our study that may inform practice.

**Table 1. Insights for emergency healthcare logistics deployments**

| | |
|---|---|
| 1. | An advanced team is crucial for defining needs, expectations, priorities, and identifying risks, as well as facilitating legal details with local authorities. |
| 2. | Swift deployment providing adaptive operative flexibility is maintained by the delegation's multidisciplinary heterogeneity of personnel, and readiness for improvisations. |
| 3. | Coordination with both the local health system and other aid organizations operations in the disaster area is essential. |
| 4. | The global nature of the deployments demands awareness and respect to national cultural diversity of the parties involved. |

| | |
|---|---|
| 5. | The contribution of translators and local health employees is significant. |
| 6. | Integration of volunteer teams from other countries into field hospitals can fill the lack of human resources and improve operations. |
| 7. | The optimal operating period is 2-3 weeks. Substitutions and supplementary airborne logistics are required for longer missions. |
| 8. | Standardization of procedures is essential in order to optimize medical response. |
| 9. | After a few days, most medical activity becomes non-urgent treatment of the population. |
| 10. | Communication devices, information systems, and electronic medical records improve efficiency of field hospitals. |
| 11. | Before departure back to the home country, the delegation need to coordinate with local authorities the transfer of responsibility over the FFH facility, equipment, and supplies in order to ensure continuity of operations by local medical staff. |
| 12. | Ethical issues pertaining to treatment of patients and their families in disaster areas must be taken into consideration before mission deployment. |

## 6. FUTURE RESEARCH

This study contributes a set of propositions that offer a fertile and hopefully fruitful avenue for future research. The propositions can be conceptually developed and empirically tested to inform research and practice. For instance, underlying the set of propositions is the notion that military healthcare logistics may offer greater responsiveness. Is that the actual case? Are there situations in which they may not be the most responsive or appropriate? While there have been studies focusing on civilian-military aid, there is a dearth of studies focusing on emergency healthcare, FFHs particularly, in the supply chain management literature. In general, underlying the propositions are structural and infrastructural factors that offer many possibilities for future research. For instance, creativity and adaptability of human resources brought in to compose emergency healthcare logistical packages seem to be a key contributor to healthcare disaster emergency responsiveness. What specific traits form those characteristics and how can they be achieved through different structures (all-volunteer personnel, civilian personnel, etc.)?

Heaslip and Barber (2014) ascertain that the greatest contribution of the military to logistical aid is in the life-sustaining days after a natural disaster, while military expertise provided over time is best in a man-made complex emergency. Underlying this proposal is the notion that the contribution of the military is contingent upon the type of disaster. Besides this consequential distinction, Heaslip and Barber (2014) contribute knowledge on the challenges faced by aid organizations during different phases of the disaster management cycle. However, whereas past research advances our knowledge by highlighting the potential role of types of disaster on the contribution of the military to logistical aid, there is a paucity of research focusing on specific types of aid. In this study, we focus on emergency healthcare services, a type of contribution of the military to the logistical aid commonly encountered across various types of disasters, and on unique and little-known healthcare logistics systems, the FFHs. Although FFHs are deployed across a broad spectrum of disasters, and we examine factors that confer this logistical system responsiveness in general, future studies may consider further uncovering specific factors that may be associated to responsiveness in each distinctive phase of the disaster management cycle. Future research may also examine whether military FFHs are more effective in contributing emergency healthcare services in certain types of disaster than others.

Our analysis suggests that the ability to cooperate, coordinate, and incorporate or become part of another team may facilitate the fit between the military FFH structure and the high uncertainty, evolving needs, and complexity caused by sudden-impact disasters. One key action we identify in this process is the ability and willingness to hold open discussions to establish

clear lines of responsibility and relinquish control. Prior research suggests that different types of disaster also impact the challenge of achieving civil-military coordination (Cross, 2014; Heaslip, 2011; Heaslip et al., 2012; Kovács, Tatham, & Larson, 2012; Rietjns et al., 2007). Future research may examine whether the ability to hold open discussions have different impacts in different types of disaster and what other factors may contribute to the ability to cooperate or effectively become part of another team under different phases in emergency healthcare.

Some of the very factors that may confer responsiveness to military FFHs, such as the availability of dedicated and specialized equipment, may also lead to unwanted outcomes, such as inhibiting the search for more effective plans of action. An illustrative example related to our point seems to have been the availability and use of military aircraft to deliver food in Sudan in 1985. According to Cuny (1989), various specialists have argued that the use of military aircraft delayed key decisions on alternative methods and concealed delivery issues with the route from the airports out to rural populations. Therefore, a question of critical importance is when military logistical systems to provide healthcare aid may be inappropriate or less effective. Are there trade-offs or contingencies involved that can inform planning and selection of resources?

We identify the capability to rapidly reconfigure modules of personnel and equipment as one potential contributor to healthcare services disaster responsiveness and the capability to integrate and coordinate efforts with multi-agencies as another. According to previous research (e.g., Peng, Schroeder, & Shah, 2008), routines are a critical source of capabilities. As healthcare logistics systems deployed in the aftermath of sudden-onset disasters operate in a politicized environment (Tomasini & Wassenhove, 2009b) and involve different types of organizations, each with different structures, capacities, and goals (Balcik et al., 2010), understanding underlying bundles of routines that support coordination and integration is an important area for future research. The same potential is valid for underlying bundles of routines that support rapid reconfiguration of the system. Knowledge stemming from these areas can not only contribute to the humanitarian aid operations but may also inform the supply chain management literature in general.

Another aspect that future researchers can further develop is the concept of healthcare services disaster responsiveness proposed in this study. Future research can further advance the concept, propose theoretically derived measurement items, and validate them empirically. Future research can also examine military foreign hospital deployments from other armed forces in different countries to compare, contrast, and replicate the findings of our study. They can also formally compare the structure and operations of all-volunteer forms of these self-sufficient healthcare systems with a military structure to uncover additional factors and processes.

Finally, system dynamics has proven very useful in modeling complex systems (Besiou et al., 2011). Future researchers can use this body of knowledge to capture interdependency between the factors proposed in this study under different scenarios. Simulation models can assist researchers and managers alike to generate insights into the composition and deployment of healthcare logistics packages to different areas under various circumstances.

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## Appendix 1. Brief description of IDF disaster relief missions

| Country | Brief description of FFH |
|---|---|
| Armenia | In December 1988, a 7.1 magnitude earthquake occurred in Kirovakan, Soviet Armenia. The IDF Medical Corps deployed a field hospital to Kirovakan. The FFH team included general and orthopedic surgeons, anesthesiologists, experts in rehabilitation, internal and emergency medicine, nephrology, and pediatrics. The medical relief operation was originally designed to serve as a pediatric rehabilitation center combined with dialysis facilities, as requested by the Soviet authorities but eventually provided primary care. The majority of patients received ambulatory treatment, but there were additional trauma cases, gynecology-obstetrics, and a few acute general surgical cases.<br><br>Sources: [#4, appendix 3], References: Heyman, Eldad, & Wiener, 1998; Maayan et al., 1997. |
| Rwanda | In July 1994, the IDF deployed 3 teams sequentially for 6 weeks to Goma, Zaire, following tribal strife in Rwanda with a consequently displaced population subjected to large-scale epidemics (principally cholera and dysentery) and famine. The length of the operation requiring team substitution every 2 weeks, and with replacements and supplies arriving by subsequent cargo airplanes, enabled a continuous prolonged operation. In each team there were experts in internal medicine and pediatrics with subspecialties, clinical microbiology/tropical medicine, critical care, anesthesiology and neonatology, general and orthopedic surgeons, and gynecologists. The FFH comprehensive multidisciplinary facilities provided primary and secondary care. The FFH composed of a triage unit, pediatric, medical and surgical wards, and diagnostic facilities.<br><br>Sources: [#4, appendix 3], References: Heyman et al., 1994; 1997; 1998. |
| Kosovo | The conflict in Kosovo in the 90s escalated in 1999, causing more than 1 million people from Kosovo to flee from their country to the neighboring countries of Macedonia and Albania. In April 1999, the IDF provided medical services to the refugees. The structure of the hospital was composed of several wards: emergency room, internal medicine, obstetrics and gynecology, pediatric and neonatology, delivery, pharmacy, laboratory X-ray, and security. Twenty hours after arriving in Macedonia, the FFH became functional in the Brazda camp. The IDF field hospital became the referral center for all other primary medical teams. Most of the patients were treated for infections (because of poor sanitary conditions in the refugee camps), exhaustion, and chronic illness (heart disease, diabetes, etc.).<br><br>Sources: [#5, appendix 3], References: Amital, Alkan, Adler, Kriess, & Levi., 2003. |
| Adapazari, Turkey | On August 17, 1999, a major earthquake (7.4 Richter) occurred in western Turkey. The city of Adapazari was severely hit. The Israeli field hospital was sent by the Israel Defense Forces (IDF) command. The IDF field hospital located in Adapazari provided advanced surgical and medical services; it included trauma care and life-saving surgeries and was ready to accept patients in 24 hours after arrival on site. The site included 5 beds for intensive care treatment and 80 beds for general hospital admission, including internal medicine, obstetrics and gynecology, and surgery. The hospital staff was overall composed of 102 personnel acting as a secondary referral center.<br><br>Sources: [#1, appendix 3], References: Bar-Dayan et al., 2000; Finestone et al., 2001; Finestone et al., 2014; Halpern et al., 2003; Margalit et al., 2002; Wolf et al., 2001. |
| Duzce, Turkey | In Nov 1999, an earthquake of 7.2 magnitude struck Turkey, this time in the region of Duzce. The IDF Medical Corps field hospital was sent 3 days after the disaster. It functioned for 9 days, aiming to substitute for a part of the damaged medical facilities. It acted as a secondary referral center providing specialized and surgical care The hospital structure included 7 clinical branches: emergency room (triage), operation room (OR), surgical intensive care unit, internal medicine, orthopedics, pediatrics, obstetrics, and gynecology. The Israeli field hospital managed to fill the gap in the local medical system and, during its peak operation, its capacity was 300 patients per day. The field hospital focus was on secondary medical care rather than primary and urgent care.<br><br>Sources: [#1, appendix 3], References: Bar-Dayan et al., 2005. |

| | |
|---|---|
| Bhuj,<br><br>India | On January 26, 2001, a 7.7 Richter earthquake occurred in India, with the epicenter located in the city of Bhuj. The IDF-led relief activity in India departed within 84 hours after recruiting personnel from both regular army and reserve units and initiated hospital activity at site on day 6. The field hospital had a fully self-sufficient tent enactment with 30 beds and included auxiliary services units such as radiology, laboratory and medical supplies, and a logistical support unit. The total number of personnel deployed for the India operations was 97.<br><br>Sources: [#2, appendix 3], References: Bar-On, Abargel, Peleg, & Kreiss, 2013. |
| Port au Prince, Haiti | A 7.2 Richter magnitude earthquake struck Haiti in January 2010. The Israel Defense Forces Medical Corps field hospital was on site and operational 89 hours after the earthquake and provided medical care to many patients during its 10 days of operation. The hospital brought all required supplies in order to stay independent and provide fast deployment, including medical requirements such as antibiotics, imaging machines and laboratory facilities, and energy sources and accommodations. The field hospital consisted of 121 hospital staff members, divided in different units, including medical, surgical, pediatric, orthopedic, gynecologic, ambulatory and auxiliary. The capacity of the field hospital was 60 inpatient beds, which could be expanded to 72.<br><br>Sources: [#1, #2, and #3, #7, appendix 3], References: Farfel et al., 2011; Finestone et al., 2001; Kreiss et al., 2010; Levy et al., 2010; Merin et al., 2011; Peleg et al., 2010; Pinkert et al., 2013; Yitzhak et al., 2012. |
| Japan | An earthquake of 9.0 on the Richter scale struck Japan on March 11, 2011. It caused a tsumani 250 miles at northeast Honshu. The IDF sent a delegation to build a small scale FFH in the format of a clinic. Its clinic was located on the east coast in the town of Minami-Sanriku. It served mainly as a referral unit for diagnostic and medical treatment. It was staffed with 55 personnel. The structure of the FFH consisted of several wards: registration-triage and discharge, gynecology, internal medicine, laboratory, surgery, pediatrics, pharmacy, laboratory and imaging, and a logistics command center. Also, a team of 8 translators helped the FFH crew. In addition, there were an imaging crew equipped with ultrasound and X-ray, a hematology-microbiology-chemistry laboratory, and wireless services.<br><br>Sources: [#6, appendix 3], References: Finestone et al., 2001; Merin et al., 2012; Pinkert et al., 2013. |
| The Philippines | The typhoon Haiyan struck the Philippines on November 8, 2013. Five days after the event, an IDF team from Israel was assigned by the Philippines government to provide medical assistance to the city of Bogo, where a local hospital serving more than 250,000 people was operating at partial capacity. The FFH team in the Philippines decided to combine its physical setup with the local structure and support the local medical staff with its experienced medical group, to provide maximum benefit and thereby create one integrated medical infrastructure. Although the IDF team had 25 physicians representing most medical subspecialties and first-class logistics support, they decided to relinquish sole decision-making authority and improvised to establish a model of cooperation with the local healthcare administrators.<br><br>Sources: [#6, appendix 3], References: Marom et al., 2014; Merin et al., 2014; Weiser et al., 2015. |
| Nepal | A 7.8 Richter magnitude earthquake struck Nepal on April 25, 2015. The IDF mission that established a field hospital in Kathmandu on April 29 consisted of 126 personnel including 45 physicians. They arrived with 100 tons of equipment and supplies, and capacity to treat 200 patients per day. It was the largest IDF mission deployed overseas. Its wards included 2 operating rooms, an 8-bed intensive care unit, trauma, obstetrics, gynecology, surgical, orthopedic, and imaging facility.<br><br>Sources: [#6, appendix 3], References: Merin, Yitzhak, & Bader, 2015. |

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## Appendix 2. Data on relief missions

| Country | Armenia | Rwanda | Kosovo | Turkey (Adapaz-ari) | Turkey (Duzce) | India | Haiti | Japan | Philippines | Nepal |
|---|---|---|---|---|---|---|---|---|---|---|
| Date (month, year) | Dec-88 | Jul-94 | Apr-99 | Aug-99 | Nov-99 | Jan-01 | Jan-10 | Mar-11 | Nov-13 | Apr-15 |
| Type of disaster | 6.8 Richter Earth-quake | Rwandan Refugees | Albanian Refugees | 7.6 Richter Earth-quake | 7.2 Richter Earth-quake | 7.7 Richter Earth-quake | 7 Richter Earth-quake | 9.0 Richter Earth-quake | Typhoon | 7.8 Richter Earth-quake |
| Time until initiation of FFH | 12 days | | 4 days | 24-36 hours | 63 hours | 6 days | 89 hours | 2 weeks | 5 days | 82 hours |
| Duration of deployment | 13 days | 6 weeks | 16 days | 1 week | 9 days | 10 days | 10 days | 2 weeks | 10 days | 11days |
| Number of casualties | 25,000 | Hundreds of thou-sands | | 2,627 | 705 | 20,005 | 230,000 | 28,000 | 6,300 | 9000 |
| Number of injured | 19000 | Hundreds of thou-sands | | 5,084 | 3,500 | 166812 | 250,000 | 2,800 | 28,000 | 23,000 |
| Number of beds in FFH | 25 | 50 | 35 | 80 | | 30 | 72 | | 80 | 60 |
| Total number of patients | 2,400 | 6,000 | 1,560 | 1,205 | 2,230 | 1,223 | 1,111 | 400 | 2686 | 1668 |
| Total personnel | 34 | 110 | 76 | 102 | 100 | 97 | 100 | 55 | 147 | 126 |
| Physicians | 20 | 18 | 15 | 21 | 21 | | 45 | 14 | 25 | 45 |
| Nurses | 3 | 21 | 7 | 10 | 13 | | 27 | 7 | | 29 |
| Paramedics and Medics | 7 | 4 | 2 | 18 | 19 | | 21 | | | |
| Pharmacists | 1 | 2 | 1 | 1 | | | 2 | 1 | 1 | 1 |
| Radiology Technicians | 1 | 1 | 1 | 1 | 1 | | 2 | 1 | 1 | 1 |
| Laboratory Technicians | 1 | 1 | 1 | 1 | 1 | | 3 | 2 | 1 | 1 |

## Appendix 3. Case study interviewees

| | Title1 | Position as participant in missions2 | Time period |
|---|---|---|---|
| #1 | Ph.D. in Policy, Strategy and Administration of Large-scale Emergency Situations, in the field of Response to Large-scale Sudden Disasters. | Team member, United Nations Disaster Assessment and Coordination [UNDAC].<br><br>Head of the organizations F.I.R.S.T./IsraAid/ medical mission to Haiti. | (2011-2015) |
| #2 | M.D., Director of Pediatric Orthopedic Unit, Schneider Children's Medical Center in Israel. | Head of orthopedic sector in delegation to Haiti. Also, participated in mission to Turkey. | (2012) |
| #3 | M.D., Department of Medicine, Coney Island Hospital, New York City. | Volunteered as physician inside tent hospitals built by F.I.R.S.T. in Haiti. | (2011-2015) |
| #4 | M.D., Head of Department of Medicine, Mt. Scopus Hospital, Jerusalem. | Chief Medical Officer of IDF missions both to Armenia and Rwanda. | (2013-2015) |
| #5 | M.D., Orthopedic surgeon and emergency physician. Has served as Adviser on Disaster and Emergency Medicine to the Ministry of Health in Israel and has served as Director General of Magen David Adom (Israel's national Red Cross). | Medical Adviser for the Department of Peacekeeping Operations at the United Nations Headquarters in New York. Active in organizing and leading humanitarian medical rescue and assistance teams both to Ethiopia and Kosovo. | (2014) |
| #6 | M.D., Head, Trauma Unit, Shaare Zedek Medical Center, and Head, emergency hospital preparedness for mass causality, Jerusalem, Israel. | Chief Medical Officer of 3 recent missions to the Philippines, Japan, and Haiti. | (2013-2015) |
| #7 | M.D., Resident in Critical Care Division, Tel Ha Shomer and Rambam Hospitals, Israel. | Volunteered as medical resident in Haiti. | (2012-2014) |

1. All informants were directly involved in disaster relief missions and some occupied senior positions in key areas with medical responsibilities, which allowed them to gain evidence-based knowledge about humanitarian aid.

2. Several informants were highly ranked in United Nations Disaster Assessment and Coordination [UNDAC] and the Department of Peacekeeping Operations at the United Nations Headquarters in New York. Therefore, they have expert knowledge about the administrative aspects of collaboration between countries during relief missions.

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## Appendix 4. Interview protocol

*Personal background:*

1. Please tell us about yourself (education, working experience in healthcare, etc.)
2. What is your expertise (pediatrics, surgery, orthopedics, mental, obstetrics, etc.)?
3. Do you have specific training in emergency medicine? How many years? What types of injuries are you trained to treat?
4. How long have you been working in the area of disaster relief and in what capacities?
5. Have you been personally deployed in a past mission to provide medical aid as part of a foreign field hospital?
6. What is your current rank (technician, nurse, resident, M.D.)?

*Israel Defense Forces (IDF)-related questions:*

1. In which missions of IDF did you participate (date, country, etc.) and what type of disaster (earthquake, flood, civil war, etc.)?
2. What was your specific role in the missions?
3. Did you get paid for mission, insurance, etc.?
4. What type of care did the FFH provide during your mission (first aid, secondary care, etc.)?
5. What type of training did you undergo before the mission?
6. Did you see differences/progress between IDF missions that you have participated in over the years (preparation, equipment, training, chain of command)?
7. How does IDF retain knowledge and diffuse it to new staff recruited for future missions?
8. Does IDF conduct post-mission investigations after missions to learn lessons for improvement?
9. What are the advantages and drawbacks of FFHs affiliated with Israel's military over civilian organizations deploying FFHs?
10. Does IDF use specific methods developed by the military in Israel for its FFHs? Are they effective?
11. What is the impact of Israeli national culture on the behavior of staff in the disaster area?
12. What differences have you seen between FFHs built by IDF and other countries?

*Mission-related questions:*

1. How were the processes of assessment and preparation for the mission conducted?
2. What was the deployment time from disaster occurrence until arrival to the area?
3. How did you arrive (flight, ship, etc.)?
4. When did you personally join the mission? When did you leave?
5. How long did the FFH built by IDF stay in the field? What was the overall length of its mission?
6. What type of equipment did you use? What was missing and should be included in future missions?
7. What type of remedies did you use? What was missing (vaccines, blood, etc.)?
8. How was IDF cooperation with FFHs from other countries?
9. How was the cooperation with the local government/agencies/population? Did you use language translators? What could be improved?
10. Did you use Information Systems during the mission (what type)?
11. What was the structure of the foreign field hospital? What wards did it include? Can you please draw a chart? What wards do you think were missing and should be in future missions?
12. What type of injuries did you treat?
13. Did you treat non-disaster-related patients with chronic diseases, etc.?
14. What was the admission process into the hospital? How was the treatment and referral process between wards inside the hospital conducted? Can you please draw a chart? Did you accept referral patients?
15. How was the discharge process of patients? Did you refer to other FFHs or local hospitals?
16. What recommendations do you have for future missions (equipment, staff, resource utilization, cooperation with other organizations and countries)?