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ARTICLE

Ocular morbidity in natural disasters: field hospital experience 2010–2015

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Abstract

Purpose To determine the characteristics of ocular injuries treated by Israel Defense Forces (IDF) field hospital following three natural disasters: the 2010 earthquake in Haiti, the 2013 typhoon in the Philippines, and the 2015 earthquake and avalanche in Nepal. The purpose was to provide data, which would assist allocation of ocular resources for future disasters.

Design Retrospective database study.

Methods Ocular clinical data collected from the IDF database. Time postdisaster was divided into three periods: 4–8, 9–12, and 13–16 days. Diagnoses were categorized as disaster-related (DRD), defined as directly resulting from the disaster (mostly ocular trauma), and nondisaster-related (NDRD), defined as preexisting conditions or results of postevent living conditions problems.

Results The field hospitals began functioning 3–8 days after the disaster and continued for 10.3 ± 1.5 days. Ocular conditions were treated in 265 (4.9%) of the total 5356 patients. Sixty-five cases were DRD and 200 were NDRD. Around day 9 postdisaster the predominant ocular referral changed from DRD to NDRD.

Conclusions Deployment of a field hospital to a natural disaster area should take into account the type and geographic location of the disaster as well as the high number of nontraumatic ocular conditions.

Introduction

A disaster is defined in part as an event that disrupts the ability of a community to satisfy the needs of its population using its own resources [1, 2]. In addition to the traumatic injuries, a leading cause of morbidity and mortality in the immediate period following a disaster is the loss of local medical services and their failure to manage the crisis [2, 3]. This explains why most of the conditions treated in field hospitals after disasters are not due to trauma but are a result of the collapse of the local health and sanitation services. Although natural disasters exhibit similar patterns of morbidity, the unique epidemiology of injuries and morbidity depends on the type and location of the natural disaster. Thus, every disaster presents a unique challenge [4, 5].

The success of a field hospital dispatched in response to a natural disaster depends on appropriate preparation of the medical teams, equipment and technical personnel tailored to both the type and geographic location of the disaster [6–11]. Since ocular injury management usually requires specialized ophthalmic personnel, it is important to know how much ophthalmic resources should be allocated to the

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Table 1 Demographic data of three field hospitals

	Haiti 2010	Philippines 2013	Nepal 2015
Type of disaster	Earthquake	Typhoon	Earthquake and avalanche
Urban/rural	Urban	Urban	Rural
Time from disaster to initiation of service (hours)	82	192	82
Duration of on-site service (days)	9	10	12
Total cases, *n*	1110	2686	1560
Ocular cases, *n* (% of total)	44 (4.0)	134 (5.0)	87 (5.6)
M/F, *n* (%)	503/607 (45.3/54.7)	1101/1585 (41.0/59.0)	718/842 (46.0/54.0)
Children/adults, *n* (%)	355/755 (32.0/68.0)	863/1823 (32.1/67.9)	369/1191 (23.7/76.3)
Number of ocular surgeries	2 (0.2%)	14 (0.5%)	1 (0.1%)

field hospital. Relevant questions at the planning stage would be the need for an operating microscope, vitrectomy capability and the need for intraocular lenses. Further, what surgical skills are most relevant: vitreoretinal, lens surgery or oculoplastics. The modern era has developed ophthalmologists that are usually skilled in only one of these areas.

Despite numerous publications on disasters and their management, little has been published regarding the ocular aspects. This study aims to describe the ocular conditions seen at Israel Defense Force (IDF) field hospitals in order to improve planning of such field hospitals for future events.

Methods

All patient encounters listed in the IDF field hospital database regarding the Haiti earthquake of 2010, the Philippine typhoon of 2013, and the Nepal earthquake and avalanche of 2015 were retrospectively reviewed. The IDF dispatched field hospitals to these disaster sites. The ophthalmic service consisted of a clinic, operating room, and either one or two ophthalmologists, and began functioning 3–8 days after the event for an average of 10.3 days. This study followed the tenets of the Declaration Helsinki and was reviewed and was approved by the IDF Ethics Committee.

Data gathered from the records included age and gender; major complaints, physical examinations, diagnostic tests performed, mechanism of injury, diagnoses, treatments, and surgical procedures; and time lapsed from the event to presentation at the hospital. The times were divided into 3 periods from the event: 4–8, 9–12, and 13–16 days. Referrals to the field hospital were categorized as disaster-related diagnoses (DRD), defined as ocular trauma caused by the disaster, and nondisaster-related diagnoses (NDRD), defined as ocular conditions that were preexisting or related to the collapse of the ordered environment and sanitation system.

Statistical analysis

Demographic factors (age, gender) and ocular injuries were stratified according to the type of the natural disaster and by time post disaster. Patients up to 18 years of age were classified as children and 18 and above as adults. Surgical procedures were defined as those procedures that are usually done in an operating room. Statistical analyses were performed with SPSS software version 17.

Results

The type and location of each disaster, duration of functioning of each field hospital and the number of patients treated are summarized in Table 1. A total of 5356 patients were treated in the field hospitals during the three disasters: 3034 (56.6%) were female and 1587 (29.6%) were children under 18. Of these, 265 patients (4.9%) had ocular diagnoses (DRD and NDRD): 44 out of 1110 patients (4.0%) in the Haiti earthquake, 134 out of 2686 (5.0%) in the Philippines typhoon, and 87 out of 1560 patients (5.6%) in the Nepal earthquake and avalanche. Overall 17 surgeries were perfumed, only three of which were due to DRDs (Table 1): one extensive face and scalp laceration repair in Nepal, and two eyelid lacerations with lid margin involvement repair in Haiti. The other surgeries were for NDRDs indications: pterygium surgeries performed in the Philippines for 14 patients with vision-compromising pterygiums. In addition, 34 minor procedures such as repair of minor eyelid lacerations, superficial corneal foreign body removals, and suture removals were performed (Table 2).

The IDF field hospital in Haiti was operational 82 h after the 7.0 Mw earthquake, which hit 25 km southwest of the capital of Port-au-Prince, and functioned for 9 days. The field hospital in the Philippines was functioning 192 h after Typhoon Haiyan, known as Super Typhoon Yolanda, hit the center of the country, and operated for 10 days.

Table 2 Disaster-related and nondisaster-related diagnoses stratified according to the disaster

Chief diagnoses, disaster-related	Haiti earthquake 2010	Philippines typhoon 2013	Nepal earthquake and Avalanche 2015
Face scalp laceration	12	0	1
Eyelid eyebrow laceration	4	1	0
Loose sutures/need for sutures removal	4	0	0
Orbital fractures	0	1	2
Exposure keratitis	0	2	4
Foreign body	1	6	6
Subconjunctival hemorrhage	2	1	4
Conjunctival laceration	1	0	0
Blunt trauma	6	3	4
Penetrating ocular trauma	0	0	0
Disaster-related diagnoses – sum	30	14	21
Chief diagnoses, nondisaster-related	**Haiti earthquake 2010**	**Philippines typhoon 2013**	**Nepal earthquake and Avalanche 2015**
Conjunctivitis	9	6	22
Cataract	1	38	7
Pterygium/pinguecula	0	32	3
Glaucoma	0	2	1
Diabetic retinopathy	0	3	1
Refractive disorder	0	15	10
Dry eye	2	12	8
Corneal ulcers	0	2	1
Iris atrophy (old)	0	0	2
Optic atrophy (old)	0	0	1
Chalazion/blepharitis	0	1	9
Ectropion/entropion	2	0	1
Eyelid lesion	0	2	0
Consulting	0	7	0
Nondisaster-related diagnoses – sum	14	120	66

Treatment began in Nepal 82 h after the 7.8 Mw Gorkha earthquake and Everest avalanche and operated for 12 days. Each field hospital treated about 170 patients daily for an average of 10.3 days. The largest number of patients, 2685, was managed at the Philippines typhoon field hospital in 2013.

Of the 265 ocular patients' records, 65 (24.5%) were categorized as DRDs and 200 (75.5%) as NDRDs, a ratio of 1:3 (Table 2). The majority of ocular conditions (229, 86.4%) were treated after day 8 of the disaster; 56 of the 65 DRD ocular injuries (86.2%) were treated during the first 12 days post disaster, and 119 of the NDRD (59.5%) were treated during days 13-16 post disaster. Only 6% of the referrals on days 4–8 were NDRD (Table 3).

The commonest injuries seen in the 65 DRDs were eyelid and scalp lacerations (13 and 5 of 65, 27.7%), blunt trauma (13/65, 20.0%) and ocular surface foreign bodies (13/65, 20.0%). No case of penetrating ocular trauma presented to any of the field hospitals. The commonest conditions among the 200 DNRDs were cataract (43/200, 21.5%), chronic conjunctivitis (37/200, 18.5%), and pterygium/pinguecula (35/200, 17.5%) (Table 2).

The greatest number of DRDs were treated in the Haiti earthquake, 30 out of 44 ocular diagnoses (68.1%). The Philippines typhoon had the least DRDs: 14 out of 134 ocular diagnoses (10.4%).

The type of acute ocular injuries treated in the field hospitals differed between the three disasters. The most common traumatic ocular injuries were face and eyelid lacerations (16/30, 53.3%) and blunt ocular trauma (6/30, 20%) in the Haiti earthquake; ocular surface foreign bodies (6/14, 42.9%) and blunt trauma (3/14, 21.4%) in the

Table 3 Disaster-related diagnoses and nondisaster-related diagnoses stratified according to time of presentation

Diagnosis	Time to presentation from the disaster (days)			Total (*n*)
	4-8	9-12	13-16	
Face & scalp laceration	2	10	1	13
Eyelid eyebrow laceration sutured debridement	4	1	0	5
Suture removal	0	3	1	4
Orbital fractures	2	1	0	3
Exposure keratitis	4	0	2	6
Foreign body	4	6	3	13
Subconjunctival hemorrhage	4	2	1	7
Conjunctival laceration	0	0	1	1
Blunt trauma	4	9	0	13
Penetrating ocular trauma	0	0	0	0
Total DRDs	24 (9.1%)	32 (12.1%)	9 (3.4%)	65 (24.5%)
Chronic conjunctivitis	9	11	17	37
Cataract	1	16	29	46
Pterygium/ pinguecula	0	9	26	35
Glaucoma	0	3	0	3
Diabetic retinopathy	0	3	1	4
Refractive disorder	1	10	14	25
Dry eye	0	11	11	22
Corneal ulcers	0	0	3	3
Iris atrophy (old)	0	1	1	2
Optic atrophy (old)	0	0	1	1
Chalazion/blepharitis	1	3	6	10
Ectropion/entropion	0	2	1	3
Eyelid lesion	0	0	2	2
Consulting	0	0	7	7
Total NDRDs	12 (4.5%)	69 (26.0%)	119 (44.1%)	200 (75.5%)

Philippine typhoon; and ocular surface foreign bodies (6/21, 28.6%), and exposure keratitis and subconjunctival hemorrhage (4/21, 19%) in the Nepal earthquake-avalanche.

Discussion

The experience of the IDF field hospitals dispatched to three different natural disasters in different geographic regions highlights important patterns that may improve preparation for such efforts in the future.

The type of acute ocular injuries treated in the field hospitals in our study differed according to the nature of the disaster, in line with previous reports [11, 12]. In the Haiti earthquake, face and eyelid laceration and ocular blunt trauma were the most common due to the collapse of buildings. In the Philippines typhoon, ocular foreign bodies and blunt trauma were the most common injuries due to the strong winds and collapse of buildings. In Nepal, the earthquake and avalanche resulted mainly in foreign bodies, blunt trauma, exposure keratitis, and subconjunctival hemorrhage.

With increasing time from the disaster, the nature of the ocular conditions presenting to the field hospitals changed from trauma related to chronic conditions such as cataract, pterygium, dry eye, and refractive errors (Fig. 1). Indeed, of all the ocular conditions treated in the three field hospitals, 75.5% were NDRDs. This is consistent with the data from the reports on the 2011 earthquake in Japan, where pre-existing ocular conditions were more common than trauma-related conditions [7, 8].

This change in the nature of pathology presenting to the field hospital was observed in other medical disciplines as well, with the shift occurring from around the ninth day postdisaster [13–15]. This demonstrates the importance of establishing the field hospital soon after the disaster; assistance with DRDs is most necessary in the first 9 days postdisaster.

The type of chronic ocular problems, the NDRDs, which presented to the field hospital, varied according to the geographic location of the disaster [16–18]. In our study, the tropical maritime climate of the Philippines with high ultraviolet (UV) light exposure, the "pterygium belt" located between 37 degrees north and south of the equator [16], cataract (38/120, 31.7%) and pterygium (32/120, 26.7%) were most frequent. In Nepal and Haiti, chronic conjunctivitis was the most frequent (22/66, 33.3%; 9/14, 64.3%, respectively) diagnosis; probably related to the poverty and poor sanitation in these regions [19].

Surprisingly, few vision-threatening eye injuries were seen at our field hospitals. No penetrating eye injury was observed in any of the three disasters. Most of the DRDs were lacerations of the eyelids and the periorbital area – findings compatible with the reports from the 2011 earthquake in Japan [7, 8, 20], which may be explained by the protection of the eye by the bony orbit and eyelids.

A possible reason for the surprisingly low number of penetrating eye injuries may be that some of these cases were treated by other facilities in the area [21–24]. Pradhan et al. recently reported the Tilganga Institute of Ophthalmology, Kathmandu experience of the Nepal 2015 earthquake [24]. This major tertiary ophthalmology referral center, serving the large cities as well as the

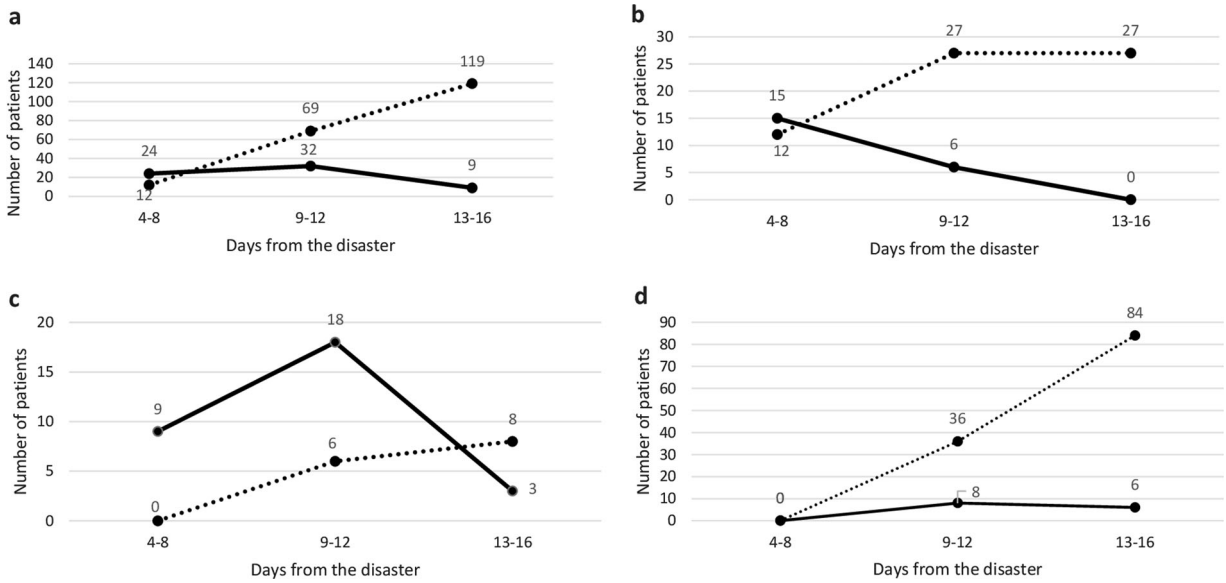

Fig. 1 Number of ophthalmic consultations (DRD and NDRD) according to days from the disaster. **a** Total consultations, **b** Nepal earthquake, **c** Haiti earthquake, and **d** Philippines typhoon. Solid lines represent disaster related consultations, and dotted lines represent nondisaster related consultations

distant districts of Nepal, treated 59 DRDs including 23 cases of closed-globe and 8 cases of open-globe trauma during the 4 months postdisaster (average presentation was 14 days postdisaster) [24]. These 31 severe ocular injuries were <0.15% of the 22,000 earthquake-related injuries throughout Nepal [24].

Since the IDF field hospitals were the first significant medical force with modern surgical abilities deployed in all three disasters, and the local services were not able to perform complicated intraocular surgery (because of logistic problems - electricity shortfalls and lack of expertize), it appears that most of the local ocular DRDs were treated at the local IDF field hospitals. Although there were other local medical services active in the acute postdisaster period, these were smaller and without significant ophthalmic resources and thus would not select against patients with penetrating eye injuries seeking care at the IDF facilities during the 3–8 days postdisaster.

Therefore, the low rate of severe ocular trauma suggested in our study and others, specifically the absence of open globe injuries at the IDF field hospitals suggest that open globe injuries in natural disasters are relatively uncommon [24].

This data is useful in selecting the most suitable ophthalmologist to be sent on such missions. In view of the low rate of open globe injuries and relatively higher incidence eyelid lacerations, it appears that an oculoplastic surgeon would be better suited to manage the acute ophthalmic problems than a surgeon with skills limited to intraocular surgery.

Unfortunately, natural disasters do occur. Responses to them should be tailored to the type and geographic location of the event, and the population affected. Only proper assessment of these factors in advance will ensure optimal preparation of the field hospital and staff. To the best of our knowledge, this is the first study that compares the nature of ocular injuries caused by different types of natural disasters in different parts of the world. The collection of data from the database of the same service for three unrelated disasters has the advantage of uniformity of data recording and interpretation. Further research areas include similar study of the experience of other field hospitals in other types of natural disasters and in other geographic regions. It would also be interesting to compare ocular injuries resulting from natural disasters and man-made disasters: the 5% eye injury rate in this study is significantly lower than the 10% reported in man-made disasters, such as military clashes. Moreover, the severity of eye injuries resulting from natural disasters is much lower than military injuries, and the NDRD proportion is higher than the corresponding disease and non-battle injury proportion in military clashes [25–30].

Summary

What was known before

- Despite numerous publications on disasters and their management, little has been published regarding the ocular aspects.

What this study adds

- To the best of our knowledge, this is the first study that compares the nature of ocular injuries caused by different types of natural disasters in different parts of the world.
- Deployment of a field hospital to a natural disaster area should take into account the type and geographic location of the disaster as well as the high number of non-traumatic ocular conditions, in order to tailor the equipment and medical team to the population in need.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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