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Disaster preparedness and response improvement: comparison of the 2010 Haiti earthquake-related diagnoses with baseline medical data

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Objectives **Disaster medicine research generally lacks control groups. This study aims to describe categories of diagnoses encountered by the Belgian First Aid and Support Team after the 2010 Haiti earthquake and extract earthquake-related changes from comparison with comparable baseline data. The hypothesis is that besides earthquake-related trauma, medical problems emerge soon, questioning an appropriate composition of Foreign Medical Teams and Interagency Emergency Health Kits.**

Methods **Using a descriptive cohort study design, diagnoses of patients presenting to the Belgian field hospital were prospectively registered during 4 weeks after the earthquake and compared with those recorded similarly by Médecins Sans Frontières in the same area and time span in previous and later years.**

Results **Of 7000 triaged postearthquake patients, 3500 were admitted, of whom 2795 were included and analysed. In the fortnight after the earthquake, 90% suffered from injury. In the following fortnight, medical diseases emerged, particularly respiratory (23%) and digestive (14%). More than 53% developed infections within 3 weeks after the event. Médecins Sans Frontières registered 6407 patients in 2009; 6033 in 2011; and 7300 in 2012. A comparison indicates that postearthquake patients suffered significantly less from violence, but more from wounds, respiratory, digestive and ophthalmological diseases.**

Conclusion **This is the first comparison of postearthquake diagnoses with baseline data. Within 2 weeks after the acute phase of an earthquake, respiratory, digestive and ophthalmological problems will emerge to the prejudice of trauma. This fact should be anticipated when composing Foreign Medical Teams and Interagency Emergency Health Kits to be sent to the disaster site.** ***European Journal of Emergency Medicine*** **24:382–388**

European Journal of Emergency Medicine 2017, **24**:382–388

Keywords: Belgian First Aid and Support Team, diagnosis, disasters, earthquakes, field hospitals, foreign medical team, Haiti, internally displaced person, Interagency Emergency Health Kits, Médecins Sans Frontières/Doctors Without Borders

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Received 28 October 2015 **Accepted** 18 February 2016

Introduction

Background/rationale

The 2010 Haiti earthquake affected 3 million individuals, killing and injuring uncountable. Most healthcare facilities and many healthcare providers were affected themselves. A quarter of the population was relocated in temporary shelters [1].

This disaster resulted in an immediate global humanitarian response. The Belgian First Aid and Support Team (B-FAST), with trained rescue, medical and logistic professionals cooperating with diplomatic and security personnel, was the first international team with an operational field hospital (FH) in the area [2]. From day 2 after the event, the team provided acute care to about 7000 patients during the first 4 weeks after the earthquake, retrieving medical supplies from preconfigured Interagency Emergency Health Kits (IEHK) [3].

A prerequisite to adopting an evidence-based approach in humanitarian response is the need to assemble solid

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website (*www.euro-emergencymed.com*).

This study is a result of a thesis submitted in partial fulfilment of the requirements for the degree of European Master in Disaster Medicine.

evidence from the results of relevant empirical studies [4]. Collection of reliable data will always be difficult in emergency situations as healthcare providers prioritize treating casualties over documenting [5–8]. Published reports generally elucidate immediate effects (estimated numbers of dead, injured and displaced) and late consequences such as outbreaks and mental health problems [9,10]. Little research has examined the transition from acute response to the recovery phase, merging disaster-related features with pre-existing local pathology and health issues secondary to disruption of the healthcare system, poor sanitary conditions and crowded internally displaced person (IDP) camps [7,10–13]. This phase occurs when most disaster-relief teams have left and there is no evidence of when a 'return to baseline pathology' can be expected [14]. This study is the first to compare postearthquake diagnoses with baseline data of the same affected area and time span.

Objectives

The aim of this study is to document diagnoses in patients presenting to an FH or to outreach teams in IDP camps; to compare those with baseline medical data of patients from the same area during the same time span before and after the event; and to discuss implications and formulate recommendations for future disaster-relief operations [15].

The hypothesis is that besides earthquake-related trauma, medical problems emerge, questioning an appropriate composition of foreign medical teams (FMT) and resources in the IEHK sent to the disaster site.

Methods

Study design

A retrospective descriptive cohort analysis was carried out on prospectively obtained medical records, collected by B-FAST between 14th January and 2nd February 2010, and compared with data prospectively collected by Médecins Sans Frontières/Doctors Without Borders (MSF) in the corresponding weeks of the year in 2009, 2011 and 2012 (see Table, Supplemental digital content 1, *http://links.lww.com/EJEM/A108* situating the corresponding periods).

The study protocol was approved by the Ethical Committee of the Universitair Ziekenhuis Brussel, Belgium.

Setting

B-FAST erected an enhanced level I Medical-Surgical FH with units for triage, emergency care, surgery, recovery and a 20-bed hospitalization unit. The B-FAST team comprised an Urban Search And Rescue section, 12 physicians, 34 nurses, two pharmacists and 20 logisticians and incorporated Haitian nurses, translators and clerks (see Table, Supplemental digital content 2, *http://links.lww.com/EJEM/A109* listing the B-FAST team composition). Their Outpatient Assistance Team (OAT) provided local healthcare to seven IDP camps.

Patients presented to the FH or the OAT by their own means or were introduced by outreach teams. Triage performed by a trained nurse filtered patients with minimal complaints who were discharged with symptomatic treatment, but not registered. For all patients receiving care in the FH or IDP camps, two WHO health cards were completed, registering age, sex, all physical complaints and one single primary diagnosis. Names were only written on the form provided to the patient, not on the copy retained for this study. Each patient was additionally questioned, examined and diagnosed by physicians, treated on the spot if possible and vaccinated when necessary. Patients were hospitalized if necessary or treated ambulatorily with explanations in their own language. Materials and drugs were retrieved from preconfigured IEHK.

MSF, present in Haiti since 1991, opened the Martissant Medical Services in 2006, with, among other facilities, an Outpatient Department-Emergency Room and a 20-bed hospital. MSF recruited patients from their Outpatient Department-Emergency Room and OATs going into IDP camps. At least two trained physicians and nurses examined these patients, registering age, complaints, main diagnoses, and treatment or follow-up on MSF-adapted WHO patient forms [16]. Lab, X-ray device and trained technicians were available 24/7.

Participants: cohort patient selection

Patients from both B-FAST and MSF originated from the same districts in Port-au-Prince: Delmas, Centre-Ville, Carrefour, Cité-Soleil, Bel-Air and Martissant. Both OATs visited the same IDP camps and accepted all patients presenting, but only registered patients were included in the study.

Variables

Diagnoses were made on the basis of complaints and physical examination as the B-FAST team had little access to laboratory or imaging diagnostic capability. One single diagnosis per patient was registered according to a list of 40 possible diagnoses adapted from case descriptions in the WHO Field Manual on Communicable disease control in emergencies and the Sphere Project Handbook [16,17] (see Table, Supplemental digital content 3, *http://links.lww.com/EJEM/A110* listing all categories and diagnoses case descriptions in detail). These diagnoses were post-hoc categorized on the basis of adapted ICD-10 codes (Table 1) [18]. Three extra categories were subanalysed, regrouping similar diagnoses from different categories: earthquake-related injury was divided into accidental trauma (amputations, fractures, contusions) versus acute skin wounds and

Table 1 List of diagnoses and categories, with subanalysis groups

Diagnosis category	Includes the following diagnoses
Respiratory	Acute upper and lower tract infection*, asthma crisis
Ophthalmological	Eye infection*, irritation
Digestive	Watery and bloody diarrhoea*, abdominal pain, malnutrition, cholera*, icterus
Neurological	Suspected meningitis*, flaccid paralysis, cerebrovascular accident, headache, convulsions
Genitourinary	Urinary tract infection*, sexually transmittable disease*, gynaecological-obstetrical
Dermatological	Skin and subcutaneous tissue infections*
General	Surgical cases other than trauma, neonatal illness, fever of unknown origin*, malaria*, measles*, neonatal tetanus*, clinical anaemia, diabetes, intoxication, death, other
Psychological	Mental/behavioural disorders
Violence	Intentional trauma, assault, sexual aggression, chemical, biological, radiological and nuclear lesions
Injury	Accidental trauma, acute wounds, burns, musculoskeletal lesions
Follow-up	Follow-up cases
Circulatory	Hypertension, cardiovascular diseases
Subanalysis groups	
Accidental trauma	Earthquake-related trauma (amputations, fractures, contusions)
Acute wounds	Earthquake-related skin wounds, lacerations, burns
Infectious	Regrouping diagnoses marked with*

*Regroups all infectious diagnoses.

lacerations to be comparable with the MSF classification; FH patients were subanalysed in terms of trauma versus nontrauma diagnoses; and infectious diagnoses were regrouped as described in Table 1.

Data sources

All B-FAST data were anonymized according to the Helsinki Convention and entered into SPSS v22.0 (IBM Corporation, Chicago, Illinois, USA). All MSF consultations were anonymously registered in an Excel database, available from the MSF Central Office in Belgium as weekly reports on the total numbers of patients in two age categories (under and over 5) with primary diagnoses on the basis of the WHO Field Manual on Communicable disease control in emergencies [16,17].

Bias

Although both B-FAST and MSF recruited patients from the same area, worked in comparable settings (outpatient clinics combined with OAT in the same IDP camps), during corresponding periods (weeks 2–5 of each year), circumstances were different and forms were filled out by different healthcare providers, possibly introducing sampling bias (see Table, Supplemental digital content 4, *http://links.lww.com/EJEM/A111* comparing B-FAST and MSF settings).

Statistical methods/data analysis

Patients with missing or unreadable data were excluded. Descriptive statistics for the discrete outcome variables are presented as frequencies [*n* (%)] broken down for age (< 5 and ≥ 5 years old) and period (4 weeks). Diagnoses of the victims examined by B-FAST during 4 weeks after the 2010 earthquake were compared with the reference data collected by MSF in the corresponding weeks in 2009, 2011 and 2012, using 99% confidence intervals, according to the Wilson 'Score' method [19].

Results

Participants

B-FAST examined over 7000 patients during the first month after the earthquake, of whom about 3500 were triage admissions. Clinical notes were available from 2931 patients. Excluding incomplete forms, 2795 (1861 in FH and 934 in IDP camps) were included and analysed in this study.

MSF reported on 6407 patients in the corresponding weeks in 2009, 6033 in 2011 and 7300 in 2012 (see Figure, Supplemental digital content 5, *http://links.lww.com/EJEM/A112* composition of the database). MSF data (2010) are lacking because the earthquake-hit facility was inoperable during the corresponding period.

Descriptive B-FAST data

Of all 2795 B-FAST patients, 1627 (58%) were females, median age 24 years (range 0–95): 25 (0–95) among females and 21 (0–87) among males. Over 37% ($n = 1045$) were minors (< 18); 371 patients (13%) were less than 5 years old.

Out of 1861 FH patients, 1071 (58%) were females, median age 25 (range 0–90), and 223 (12%) were less than 5 years old. Out of 934 IDP patients, 556 (60%) were females, median age 22 years (range 0–95), and 148 (16%) were less than 5 years old (see Figure, Supplemental digital content 6, *http://links.lww.com/EJEM/A113* comparing Haitian and B-FAST populations).

Outcome data

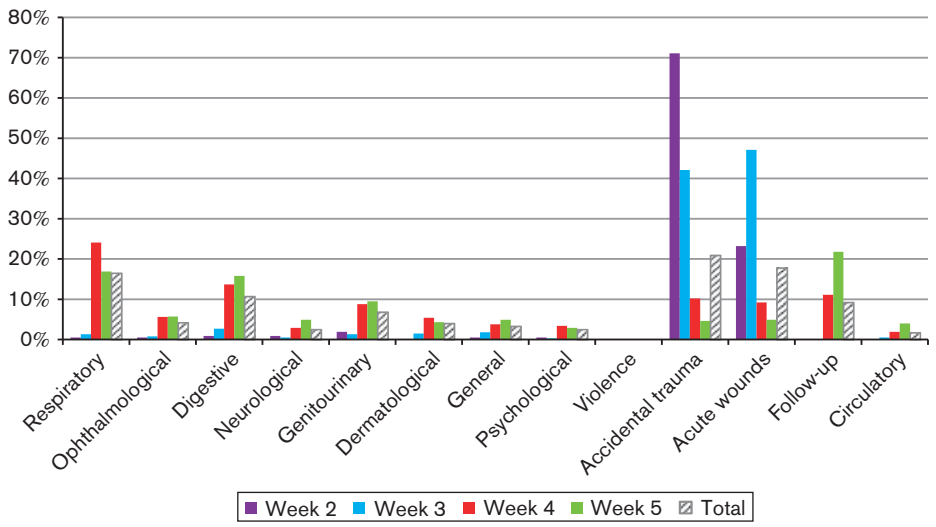
Among all B-FAST patients in the 4 weeks after the earthquake, injury ($n = 1081$ or 39%) with accidental trauma ($n = 584$ or 21%) and acute wounds ($n = 497$ or 18%) accounted for the most common diagnoses, but presented almost all in the fortnight after the earthquake (Table 2). As the load of injured patients regressed after 2 weeks, apart from follow-up injury cases ($n = 257$ or 9%), relatively more medical conditions were encountered: respiratory ($n = 462$/17%), digestive ($n = 298$/11%), genitourinary

Table 2 B-FAST results

	Number of patients in 2010 [*n* (%)]				
Category	Week 2	Week 3	Week 4	Week 5	Total
Respiratory	1 (0.5)	8 (1.3)	394 (24.1)	59 (16.9)	462 (16.5)
Ophthalmological	1 (0.5)	5 (0.8)	91 (5.6)	20 (5.7)	117 (4.2)
Digestive	2 (0.9)	16 (2.7)	225 (13.7)	55 (15.8)	298 (10.7)
Neurological	2 (0.9)	3 (0.5)	48 (2.9)	17 (4.9)	70 (2.5)
Genitourinary	4 (1.9)	8 (1.3)	144 (8.8)	33 (9.5)	189 (6.8)
Dermatological	0 (0.0)	9 (1.5)	88 (5.4)	15 (4.3)	112 (4.0)
General	1 (0.5)	11 (1.8)	62 (3.8)	17 (4.9)	91 (3.3)
Psychological	1 (0.5)	2 (0.3)	56 (3.4)	10 (2.9)	69 (2.5)
Violence	0 (0.0)	0 (0.0)	1 (0.1)	0 (0.0)	1 (0.0)
Injury	199 (94.3)	532 (89.1)	317 (19.4)	33 (9.5)	1081 (38.7)
Follow-up cases	0 (0.0)	0 (0.0)	181 (11.1)	76 (21.8)	257 (9.2)
Circulatory	0 (0.0)	3 (0.5)	31 (1.9)	14 (4.0)	48 (1.7)
Total	211 (100)	597 (100)	1638 (100)	349 (100)	2795 (100)
Subanalysis injury					
Accidental trauma	150 (71.1)	251 (42.1)	167 (10.2)	16 (4.6)	584 (20.9)
Acute wounds	49 (23.2)	281 (47.1)	150 (9.2)	17 (4.9)	497 (17.8)
Subanalysis field hospital					
FH trauma	200 (94.8)	511 (85.6)	364 (51.7)	94 (26.9)	1169 (62.8)
FH nontrauma	11 (5.2)	86 (14.4)	340 (48.3)	255 (73.1)	692 (37.2)
Subanalysis infections					
Infectious cases	3 (1.4)	37 (6.2)	874 (53.4)	143 (41.0)	1057 (37.8)

Total numbers and relative frequency per week of diagnoses categories observed during 4 weeks after the earthquake.
B-FAST, Belgian First Aid and Support Team; FH, field hospital.

Fig. 1



Proportion of observed diagnoses categories (%) per week (B-FAST, 2010). B-FAST, Belgian First Aid and Support Team.

(*n* = 189/7%), ophthalmological (*n* = 117/4%) and dermatological (*n* = 112/4%) diagnoses, producing a shift in the type of pathology (Figs 1 and 2).

Of all B-FAST patients after the earthquake, 1057 (38%) had features of infection. This was more pronounced in the subgroup less than 5 years old (*n* = 273 or 74% vs. *n* = 784 or 32% in ≥ 5 years) and the proportion of infectious diseases started increasing particularly 2 weeks after the event, increasing to more than 53% of all patients.

In children under 5, most diagnoses were of respiratory (*n* = 128/35%), digestive (*n* = 107/29%) or dermatological (*n* = 27/7%) origin; 73 (20%) suffered from injuries, of whom most had acute wounds (*n* = 38/10%), and 34 (9%) had accidental trauma.

In most IDP patients (*n* = 934), irrespective of their age, respiratory (*n* = 296/32%), digestive (*n* = 168/18%) or genitourinary (*n* = 112/12%) diseases were diagnosed; 70 (8%) had ophthalmological diseases and 58 (6%) had

dermatological diseases. Two weeks after the event, 90 IDP patients still suffered from untreated earthquake-related injury (10%) and 667 (71%) had features of infections.

Comparison between B-FAST and MSF data

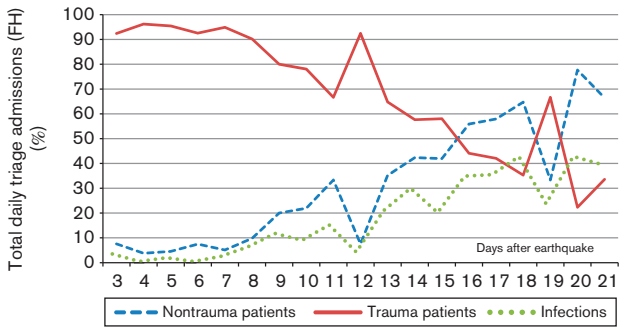
The B-FAST diagnosis categories were post-hoc compared with those registered by MSF in the year before and 2 years after the earthquake for the total patient population, for age categories (under and above 5 years old) and per corresponding week of the year [16–18].

Comparing all ages and the entire period of 4 weeks using 99% confidence intervals (Table 3 and Fig. 3), there was significantly less violence and accidental trauma, less general and follow-up cases in the year of the earthquake than before and longer after the earthquake, but there were more acute wounds, and respiratory, ophthalmological, digestive, neurological, dermatological and psychological diagnoses. There were no changes in genitourinary and circulatory diagnoses (see Figures, Supplemental digital content 7, *http://links.lww.com/EJEM/A114* and Supplemental digital content 8, *http://links.lww.com/EJEM/A115* comparing weekly diagnoses between B-FAST and MSF).

In Haitian adults and children over 5, the earthquake significantly increased the incidence of accidental trauma and acute wounds, respiratory, ophthalmological, genitourinary, neurological and psychological problems. However, there were significantly fewer violence victims than usual.

In children under 5, the earthquake predominantly increased the occurrence of acute wounds, respiratory, digestive and dermatological problems (see Figures, Supplemental digital content 9, *http://links.lww.com/EJEM/A116* and Supplemental digital content 10, *http://links.lww.com/EJEM/A117* comparison of proportion of diagnoses in both age categories).

Fig. 2



Evolution of trauma versus nontrauma patients, and infectious cases (B-FAST, 2010). B-FAST, Belgian First Aid and Support Team; FH, field hospital.

Discussion

Key results

Trauma cases represented more than 90% of all patients in the first 2 weeks after the event, of comparable size as reported by other FMT [11,12]. In the following 2 weeks, most patients (75%) presented with medical conditions and more than half of all patients showed features of infection, mostly of respiratory and digestive, but also genitourinary and dermatological origin [12,16]. This transition from trauma to predominantly nontrauma cases within 2 weeks is shown in Fig. 2.

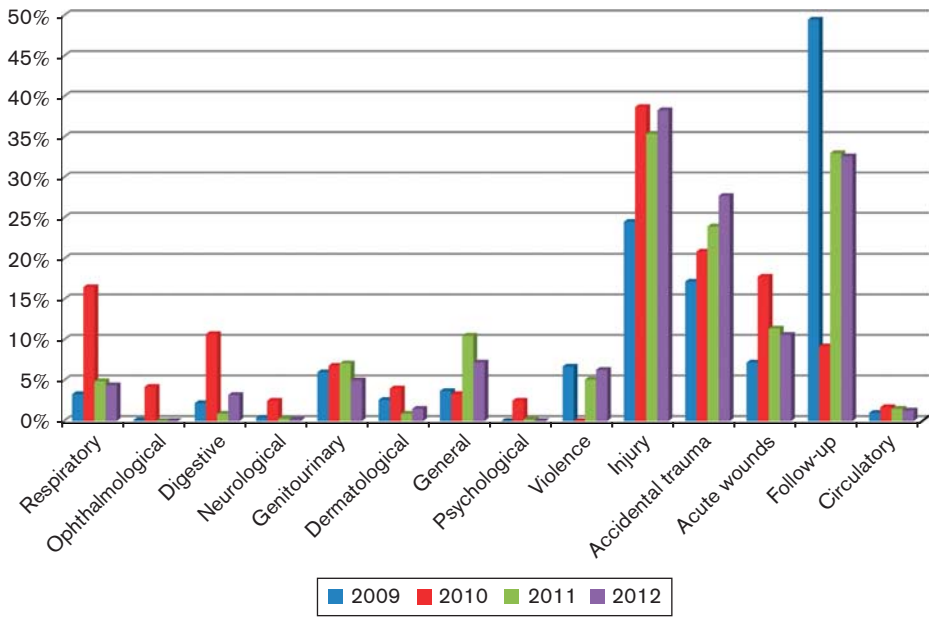
A possible explanation could be related to the shift of all major hospitals into trauma centres and the deployment of more sophisticated FH, diverting nontrauma patients to lower level FHs. In children under 5, respiratory and digestive problems emerged even more to the prejudice of trauma-related injuries as children have a lower survival rate after serious injury [1].

Table 3 Comparison of postearthquake diagnoses with a baseline

						99% CI limits		
%	MSF 2009	MSF 2011	MSF 2012	MSF mean	B-FAST 2010	Lower	Upper	Trend after the earthquake: significantly
Respiratory	3.32	4.94	4.37	4.31	16.53	14.8	18.4	More
Ophthalmological	0.08	0.05	0.04	0.06	4.19	3.3	5.3	More
Digestive	2.23	0.91	3.19	2.58	10.66	9.3	12.3	More
Neurological	0.37	0.31	0.16	0.31	2.50	1.8	3.4	More
Genitourinary	5.96	7.06	4.96	6.05	6.76	5.6	8.1	Not significant
Dermatological	2.64	0.91	1.52	1.98	4.01	3.2	5.1	More
General	3.71	10.54	7.22	8.13	3.26	2.5	4.2	Less
Psychological	0.02	0.22	0.03	0.18	2.47	1.8	3.3	More
Violence	6.73	5.14	6.26	6.14	0.04	0.0	0.3	Less
Injury (*+**)	24.46	35.44	38.33	34.04	38.68	36.3	41.1	More
*Accidental trauma	17.22	24.00	27.74	24.02	20.89	19.0	22.9	Less
**Acute wounds	7.24	11.44	10.59	10.09	17.78	16.0	19.7	More
Follow-up cases	49.48	32.97	32.60	39.79	9.19	7.9	10.7	Less
Circulatory	1.00	1.51	1.32	1.30	1.72	1.2	2.5	Not significant

Statistical significant differences (99% confidence intervals) in the proportion of observed diagnosis categories in the year of the earthquake compared with the year before and 2 years after.
B-FAST, Belgian First Aid and Support Team; CI, confidence interval; MSF, Médecins Sans Frontières/Doctors Without Borders.

Fig. 3



Proportion of observed diagnosis categories in the year of the earthquake (2010), the year before and 2 years after.

Comparison between the B-FAST data and the MSF baseline data from before and after the earthquake indicates epidemiological changes attributable to the event itself.

Earlier reports on extreme violence (armed groups, sexual and domestic abuse) and frequent traffic accidents among the Port-au-Prince population help to explain why injury seems even more present in years without a disaster [1,16]. The unexpected decrease in violent and accidental trauma in the aftermath of the earthquake is probably, respectively, because of a low profile of prostrated armed groups and the fact that roads were impassable.

Possible explanations for the marked occurrence of respiratory, ophthalmological, digestive and skin disorders following the earthquake compared with other years may be atomization of rubble dust, poor hygiene circumstances in huddled IDP camps and increased awareness of respiratory symptoms following the 2009 Haitian Ministry of Health H1/N1 flu campaign [15,17].

The increased proportions of postevent neurological and psychological diagnoses are attributable to headaches because of stress and disrupted sleep from nightmares and anxiety, which corresponds with earlier documentation on psychological trauma following earthquakes [20].

No significant changes in the occurrence of genitourinary and circulatory diseases were observed in the post-earthquake period.

Almost 38% of all patients examined by B-FAST presented with infectious diseases in the 4-week period after the earthquake. This is almost twice the baseline observed in the same period of earlier and later years. A peak incidence occurred as of the third week after the earthquake: 88% of the children under 5 and almost 45% of older patients suffered from infections.

The B-FAST findings on the marked proportion of respiratory, digestive and ophthalmological diseases are consistent with earlier reports on diagnoses after earthquakes and other disasters [13,21–23]. This study emphasizes that an important share of these are indeed earthquake related, and not only governed by seasonal variation or IDP huddle and poor sanitary circumstances.

Limitations and strengths

This study has several limitations. B-FAST and MSF worked under different circumstances and settings. Although both teams used forms based on WHO health cards and defined diagnoses from the same manual, the lack of uniform standards to register complaints, clinical features and diagnoses made comparison of datasets challenging [6,7,17]. Final diagnoses remain tentative because of a lack of lab and imaging equipment. Exclusion of patients because of missing data (in carrying out research while working against time under complex circumstances, obviously the patient has priority) has been reported by other FMT [5,7,8,14]. This study covered a limited number of Port-au-Prince districts, preventing extrapolation of results to other areas. Estimating the total population of Delmas and Martissant regions at 658,513, the B-FAST

and MSF cohort samples each represent less than 1% of this population [24].

The strengths of this study are the considerable number of patients and the comparison of diagnoses, made by physicians, of before and after an earthquake, never documented in this way before [6].

Interpretation and conclusion

For FMT to meet the changing needs of victims in subsequent phases of the disaster response, the first to be sent to the affected area are surgeons, anaesthesiologists, intensivists and ancillary nurses, together with the necessary equipment and supplies [25]. There is an early role for emergency physicians, paediatricians, gynaecologists, midwives and pharmacists [23,26]. FMTs should scale up within 2 weeks with internists, rehabilitation teams, psychologists and public healthcare personnel [2,8,26].

The existing IEHKs should be adapted to the specific medical needs of disaster victims in this phase by providing respiratory, digestive and ophthalmological drugs and supplies, rehabilitation materials, as well as paediatric formulas of essential medicines [3,15,26].

Generalizability

More research is needed to confirm the important share of medical problems in victims and IDP camps during the aftermath of different types of disasters.

More epidemiological data are needed to adapt and improve the composition of FMTs and the content of IEHKs to be deployed for all types of disasters [3,26].

The development of a standardized template, to prospectively register and subsequently report health data as well before as after disasters, would allow relevant research to improve disaster preparedness, management and mitigation on the basis of evidence in the future [4,7–9,12,18,27]. This would imply that healthcare workers locally active in disaster risk areas use the same standards to register baseline data in daily medical practice as FMT during emergency relief [14,18,28,29].

As we cannot prevent these disasters from occurring, we can at least attempt to be maximally informed and ideally prepared to deal with (most of) them.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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