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Hospital disaster preparedness in Switzerland over a decade: a national survey

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Abstract:	STUDY OBJECTIVE: To provide a comprehensive assessment of Swiss hospital disaster preparedness in 2016 compared to the 2006 data. METHODS: A questionnaire regarding hospital preparedness in 2016 was addressed to all heads responsible for Swiss emergency departments (EDs). The survey was initiated in May 2016 and finalised in December 2016. RESULTS: Of the 107 ED included, 83 (78%) returned the survey. Overall, 76 (92%) hospitals had a plan in case of a massive influx of patients, and 76 (93%) in case of an accident within the hospital itself. There was a lack in preparedness for specific situations: less than a third of hospitals had a specific plan for NRBC+B patients: Nuclear/Radiological (14; 18%), Biological (25; 31%), Chemical (27; 34%), and Burns (15; 49%), and 48 (61%) of EDs had a decontamination area. Furthermore, less than a quarter of hospitals had specific plans for the most vulnerable populations during disasters such as seniors (12; 15%) and children (19; 24%). CONCLUSIONS: The rate of hospitals with a disaster plan has increased since 2006, reached a level of 92%, but the Swiss health care system remains vulnerable to specific threats like NRBC. The lack of national legislation and Federal funds aimed at fostering hospitals' preparedness to disasters may be the root cause to explain the vulnerability of Swiss hospitals regarding disaster medicine.
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Hospital disaster preparedness in Switzerland over a decade: a national survey

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Abstract

STUDY OBJECTIVE: To provide a comprehensive assessment of Swiss hospital disaster preparedness in 2016 compared to the 2006 data.

METHODS: A questionnaire regarding hospital preparedness in 2016 was addressed to all heads responsible for Swiss emergency departments (EDs). The survey was initiated in May 2016 and finalised in December 2016.

RESULTS: Of the 107 ED included, 83 (78%) returned the survey. Overall, 76 (92%) hospitals had a plan in case of a massive influx of patients, and 76 (93%) in case of an accident within the hospital itself. There was a lack in preparedness for specific situations: less than a third of hospitals had a specific plan for NRBC+B patients: Nuclear/Radiological (14; 18%), Biological (25; 31%), Chemical (27; 34%), and Burns (15; 49%), and 48 (61%) of EDs had a decontamination area. Furthermore, less than a quarter of hospitals had specific plans for the most vulnerable populations during disasters such as seniors (12; 15%) and children (19; 24%).

CONCLUSIONS: The rate of hospitals with a disaster plan has increased since 2006, reached a level of 92%, but the Swiss health care system remains vulnerable to specific threats like NRBC. The lack of national legislation and Federal funds aimed at fostering hospitals' preparedness to disasters may be the root cause to explain the vulnerability of Swiss hospitals regarding disaster medicine.

Introduction

At the beginning of the sixteenth century, Nicolas Machiavelli in his political treatise "*The Prince*" maintained that during a storm, the overflowing impetuous river could destroy everything in its path, and that a good governor was one who built banks in calmer times (1).

Following a natural or man-made disaster, patients present to local hospitals, whose EDs are often chronically overcrowded (2). Additionally, the hospital itself can be damaged by the disaster or itself suffer a major incident like fire, power and telecommunication breakdown (3,4). The two key determinants required to minimise the impact of those events are the existence of a disaster plan and regular training through simulation exercises (5,6), as demonstrated recently during the bombing of the Boston Marathon (2013) or the Paris attacks in 2015 (5,7). Since the terrorist attacks on September 11th 2001 in New York, drills have become part of the National Bioterrorism Hospital Preparedness Plan in the USA (8), and the Federal state incites simulation development and provides financial support and coordination (9,10).

Switzerland is a federation of 26 States. As in the USA or in Germany (11), the health care system is fragmented and highly decentralised. Each state is sovereign to rule on hospital disaster preparedness legislation (12). There is no national legally binding medical standard (13), except for pandemic crises (14), infectious diseases such as HIV/AIDS, vaccines (12) and nuclear incidents (15). Switzerland is among the richest countries in the world (12) and has a system of public health surpassed only by the USA in per capita costs (16). However, disaster preparedness is costly to achieve and maintain for hospitals, with costs ranging from one to more than three million dollars per hospital in the USA (9,17). Furthermore, for-profit privately funded hospitals are more exposed to competition in the hospital or insurance markets than public institutions (12), and some data suggest their level of preparedness may be less efficient (18).

In 2006, only 82% of Swiss hospitals had a disaster plan following an national survey (19). Many hospitals have since updated their disaster plan, in particular since Switzerland co-hosted the *Eurofoot* in 2008. Unlike in the USA, there is however neither financial support nor coordination to organise drills on a national level within Switzerland.

The main objective of this study was to compare the proportion of hospitals with a disaster plan in 2016 with the proportion in 2006. Secondary objectives were to assess the type of risks hospitals were prepared for, and their declared level of preparedness.

Materials and Methods

As no validated questionnaire exists in the literature, a specific questionnaire was prepared for this survey, based on the main criteria of hospital disaster preparedness identified in a review of the literature. Queries from the 2006 survey were included to allow for comparisons with our initial survey. An email invitation to participate was sent to all heads of EDs if the ED was hospital-based and open on a 24/7 basis. The list of participating hospitals from the last survey was updated with data from the Federal Office of Public Health. Hospital-based EDs admitting adult as well as paediatric patients were included. Specialty EDs dedicated only to ophthalmology or psychiatry were excluded on account of their highly specialised structures and technical capabilities. In the case of multi-site hospital EDs, the Head of the ED decided either to consider the hospital as a single hospital or as several hospitals. Paediatric ED plans were considered only if different from the adult ED.

The survey was conducted using the online platform *SurveyMonkey*®. If no answer was received, a letter containing the questionnaire in paper format was sent. Data collection was conducted from May to December 2016.

The Human Research Ethics Committee of the State of Vaud, Switzerland was consulted; however, as no data from patients were processed, no further documentation was required.

Statistical analysis

Statistical analyses were performed using Stata 14.1 (StataCorp, College Station, TX, USA). Data are presented as mean ± standard deviation (SD), median and inter-quartile range (IQR) or as percentages. Proportions were compared using the Chi-squared test, or Fisher's exact test, and means using unpaired Student's t-test or Wilcoxon rank sum test, as appropriate. A bilateral P value <0.05 was considered statistically significant. Missing data were not imputed.

Results

In 2016, there were 107 hospitals (138 in 2006) open 24/7, which equates to 26 hospitals/10,000 km^2. Of those, 83 (78%) hospitals completed the questionnaire, with a rate that was similar to the 78% reported in the 2006 study. In 2006, 89 (82%) hospitals had a disaster plan in case of the massive influx of patients; this increased to 92% in 2016 (P=0.088). Public hospitals more frequently had a disaster plan than private ones in 2006 (P = 0.017), and, although a difference still existed in 2016 (94% for public hospital vs. 80% for private ones), it was no longer statistically significant (P = 0.107). The number of hospital beds was not associated with the existence of a disaster plan in both study periods. In 2006, there were no statistically significant differences in the percentage of disaster plans between the three main linguistic parts of the country. In 2016, however, we noticed that the French part of Switzerland had a significantly lower proportion of hospitals with disaster plans (p = 0.040). As in 2006, all university hospitals that responded had a plan in 2016 (Table 1).

Disaster plan features in 2016 (Table 2)

Most hospitals had a plan in case of the massive influx of patients or in the case of an accident within the hospital itself (76; 92%). Plans regarding casualties of specific types of disasters were present in the following proportions: Polytrauma (n=46; 58%), Chemical (n=27; 34%), Biological (n=25; 31%), Nuclear/Radiologic (n=14; 18%) and Burns (n=15; 19%). Plans addressing the needs of specific types of patients existed in a minority of hospitals: children (n=19; 24%), elderly (n=12; 15%); and migrants (n=10; 13%).

The control of hospital ED access was performed in 34 (43%) hospitals by its own technical staff, by private security services in 29 (36%), and by police forces in 24 (30%). Most hospitals (n=41; 51%) planned to separate the flow of daily patients from that of the disaster. Regarding the patient flow management, 67 (81%) hospitals used digital support on a daily basis, whereas 52 (67%) would still use such support during a disaster situation. In 79 (98%) hospitals, the plan anticipated the potential recall of additional staff; in 74 hospitals (93%) the recalled staff were from the ED, while in 71 (89%) hospitals, staff from other departments were likely to be recalled. Finally, 64 (80%) hospitals could also recall administrative staff.

Plan knowledge, learning and drills

In most cases, the medical staff were informed about the plan through periodic instruction (n=50; 64%) or by consulting the hospital website (n=49; 63%). Word-of-mouth (n=15; 19%) and pocket card (n=11; 14%) were also reported means of communication. Half of the hospitals (n=42; 52%) performed at least one simulation drill per year, while all hospitals organised at least one exercise per 3-year period. The most frequently used drill mode was activation of the Hospital Incident Command System (HICS) alone (n=38; 48%). The use of simulated patients (n=33; 41%) and cards (n=27; 34%) was less frequent (Table 2).

Figure 1 displays the degree of awareness of the plan from the staff according to the Heads of Emergency Departments. It appears that just over half of ED department heads (42; 54%) and nurses (44; 56%) knew the plan at least sufficiently. For interns, however, the proportion of adequate knowledge was lower (14; 18%).

Hospital incident Command System (HICS) (Table 2)

Most hospitals (n=70; 88%) had a HICS, the leader of which was a member of the hospital management (n=38; 56%) or the medical officer of the ED (14; 21%) in most cases. The majority (n=38; 56%) estimated the time necessary for the HICS to be operational to be 20 to 40 minutes.

Decontamination (Table 2)

Sixty percent of hospitals (n=47) had a decontamination zone for a chemical accident, 32 (41%) had one for a biological accident, 25 (32%) for a nuclear one, and 30 (39%) had no decontamination zone. The decontamination area was operational within 40 ± 25 minutes on average, with a median time of 30 minutes (IQR 60-20). The medical staff were responsible for decontamination in 26 (54%) hospitals, the hospital technical staff in 23 (48%), and fire-fighters in 19 (40%). Among hospitals equipped with a decontamination zone, 44 (92%) reported having protective masks with disposable gloves, and 38 (79%) reported providing lightweight chemical protection (PPE).

Plan development

Most of hospitals (46; 58%) had developed their plan through States' coordination, and 29 (36%) with other hospitals in their region (Annexe 1). Rescue agencies were also involved in the development of the disaster plan: Emergency medical services in 43 (54%) situations, fire-fighters in 33 (41%), and the police in 23 (29%). The Federal state and its entities (Army, Federal Office for the Protection of Population) cooperated in less than 10% of disaster plan developments.
In half of the cases (39; 49%), the Federal state required hospitals to develop a disaster plan but more frequently, the disaster plan development resulted from the initiative of a sole executive of the hospital (n=30; 38%) or due to preparation for an important event in the region (19; 24%). (Annexe 2).

Discussion

This study is the first to provide a comprehensive analysis of the evolution of the disaster and in-hospital event preparedness of Swiss hospitals.

We noticed a decrease in the total number of disaster plans in 2016. This can be explained by the decrease in the number of eligible hospitals; in 2016, multi-site hospital EDs with the same disaster plan were often counted as one. This phenomenon mainly affected the French region, which may explain the absolute reduction of disaster plans in this part of the country.

However, compared to 2006, the proportion of hospitals with a disaster plan in case of massive patient inflow in 2016 had increased to 92%. In 2012, in a similar survey covering the European Union, a rate of 82% covering the same risk was reported (20).

All university hospitals have a plan; the size of the hospital does not seem to affect the presence of a plan.

The 2015 Swiss Federal Office for the Protection of Population report approximates that severe chemical or biological accidents may occur more than once in 100 years, nuclear accidents once in 30,000 years and that international events of a social nature (e.g. terrorist attacks with NRBC) are impossible to estimate (21). When these disasters occur, decontamination is indispensable to prevent the spread of toxic agents in the hospital, thereby contaminating both patients and staff (22). In this research, only half of hospitals had a decontamination area, only a third had a specific plan for NRBC+B patients and another third had no decontamination area at all. This is a major weakness, as decontamination is not always done at the site of the accident. Furthermore, walking-wounded patients often bypass on-site treatment and decontamination stations to go directly to the nearest hospitals (23). In a similar study conducted in 2012 in Europe, 70% of hospitals had a specific plan dedicated to chemical incidents (20), while in another study conducted in 2008 in the USA, 67% of hospitals from the sample had response plans for all six categories of expected incidents (24).

Most hospitals believed that the decontamination area should be handled by care staff or by fire-fighters, but healthcare providers may not be properly trained and already busy in other tasks, with fire-fighters deployed at the accident site (10). Another issue is the time needed to setup an operational decontamination area (30-40 minutes), while the first patients may arrive in the emergency department (ED) within 5-30 minutes (25). Contaminated patients could contaminate equipment and the ED staff if they are not adequately protected. Our results in NRBC+B disaster preparedness are therefore worrying. As noted by Noto (1994), despite the fact that pure NRBC+B incidents are rare, a disaster can include NRBC+B components with related casualties; therefore, NRBC+B victims are more frequent than expected (26). However, this survey shows that basic personal protective equipment, such as PPE and protective masks, are available in most hospitals,

in a proportion similar to a recent survey of chemical hazard preparedness in hospitals in Michigan, USA (27), and as proposed by Koenig et al. (22).

Disaster plans specifically designed for particular populations of patients (elderly, children, migrants) have already proven their benefits (28,29). However, most Swiss hospitals do not have such plans. As a fifth of the population is over 65 years with a projection of more than a quarter in 2030 (30), an awareness of the lack of a dedicated plan is a first step towards preparing better Swiss hospitals ourselves. Similarly, children are often involved in disasters, and their health needs may be specific. MD George Foltin recommended that children should be given primary transport to paediatric centres, but, if this is not possible, general hospitals which normally deal with adults should have plans in place to adequately take care of children (31). Paediatric exercises, equipment and expertise are therefore essential in every hospital (31).

In case of disasters, the presence of a care team for patients' families is essential (26). This enables the ED to focus on patient care exclusively. Most hospitals report not having such resources, while half consider the care of victims' relatives to be an ED task.

During a major disaster, it is often necessary to call for additional staff (32); most hospitals have such a plan. However, regarding the size of Switzerland and its borders, staff may live in another country, where borders may be closed for security reasons (terrorism, natural disaster). This eventuality must be considered.

Knowledge of the disaster plan

Interns seem to be the less prepared professional category. This may be explained by the short periods that interns experience in the ED in Switzerland; there is not enough time to participate to the drills, nor to learn the procedures when dealing with a major incident. A 2013 Germany survey showed similar results, with only 53% of physicians knowing that there is a plan in their hospital (33).

Only half of hospitals perform at least one simulation per year while they all declare to go through at least one exercise every 3-years. As suggested by many, the retention of knowledge regarding disaster plan rules is directly related to the time since the last training session (34). Additionally, 69% of hospitals that normally use digital support in a daily situation will use paper support in a disaster situation. More frequent exercises are therefore essential to accustom the staff to this important change. Unfortunately, the lack of tangible immediate benefits makes it difficult to justify those drills, especially when time, structures and money are limited (10). In addition, the chronic shortage of care staff makes the participation of key workers in simulations, rather than their use for daily management duty, difficult. On the other hand, poor management of a disaster can result in poor publicity for the hospital, a more serious psychological impact of the disaster on employees and patients, and even lead to the closure of the hospital (10). These factors therefore contribute to heterogeneity in the degree of disaster preparedness. One possible solution is the joint conception of disaster plans between hospitals (10). Interestingly, unlike the rest of Switzerland, all hospitals in the Italian speaking region have developed a plan through regional coordination. This probably explains the widespread uniformity of responses among hospitals of the Italian speaking region with a disaster plan rate that reaches 100%.

According to Barbera et al. (2009), an additional factor that promotes hospital disaster preparedness is the presence of federal funding and guidance (10). The Swiss Federal Office for the Protection of Population supports the State's pre-hospital organisations (EMS, police, fire-fighters, Civil Protection, Army) to exercise their disasters plans (35). However, this support does not extend to hospitals that are under the State's responsibility only (12). Half of all hospitals declare that their State obliges them to develop a plan, while a minority even declare that they developed a plan because of Federal obligation. However, such obligation does not exist. Unlike in the USA, there is neither Federal nor State financial support for hospitals to organise drills in Switzerland. This lack of national coordination and funding induces a large heterogeneity in the degree of achievement of disaster plans and their testing within hospitals.

Limitations

Only 78% of eligible hospitals participated to the survey; as there are no data from non-responding hospitals, we cannot assess whether their characteristics differed significantly. We have identified 53 determinants of disaster preparedness from a medical perspective based on the literature. However, we have not investigated other aspects of disaster preparedness such as administrative or logistics preparedness. The invitation to complete the questionnaire was sent to the heads of the Swiss emergency services. The answers obtained reflect their knowledge and not necessarily the reality of the plan.

Conclusion

The 2006-2016 analysis of Swiss hospital disaster preparedness shows improvements, with 92% of hospitals declaring having a plan in the case of massive patient inflow. However, some specific situations are not covered, especially NRBC risks and paediatric victims. National guidelines, financial incentives, and simulations are still lacking.

Statement on funding sources and conflicts of interest

The authors declare no funding sources, neither conflict of interest.

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Table 1

Table 1: Hospitals' characteristics: 2006 vs. 2016				
Year	**2006**		**2016**	
Eligible EDs	138		107	
Response rate, n (%)	108 (78)		83 (78) P = (1.000)	
Characteristics	Total answers	Have a plan for massive patient inflow	Total answers	Have a plan for massive patient inflow
EDs response, n (%)	108	89 (82)	83	76 (92) P = 0.088
Public vs. Private hospital	108	P = 0.017	83	P = 0.107
Private hospital	14 (13)	8 (57)	15 (18)	12 (80)
Public hospital	94 (87)	81 (86)	68 (82)	64 (94)
Number of acute hospital beds (%)	108	P = 0.228	83	P = 0.946
<100	35 (32)	25 (71)	26 (31)	24 (92)
100-199	42 (39)	36 (86)	31 (37)	28 (90)
200-499	23 (21)	20 (87)	17 (21)	15 (88)
≥500	7 (8)	7 (100)	9 (11)	9 (100)
Hospital with intensive care unit, n (%)	64 (63)	55 (86)	59 (71)	54 (92) P = (1.000)
Linguistic regions	108	P = 0.550	83	P = 0.040
German part	71 (66)	57 (80)	60 (72)	57 (95)
French part	29 (27)	24 (83)	16 (19)	12 (75)
Italian part	8 (7)	8 (100)	7 (9)	7 (100)
University vs. non-University hospital	108	P = 0.210	82	P = 1.000
University hospital	11 (100)	11 (100)	7 (100)	7 (100)
Non university hospital	97 (90)	78 (80)	75 (91)	69 (91)

Table 2

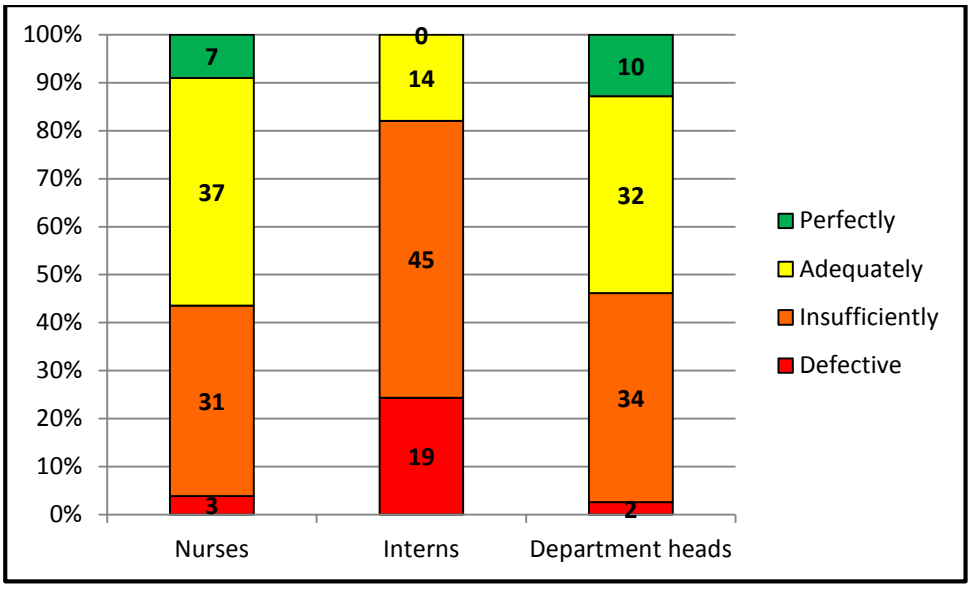
Table 2: Features of disaster plans in 2016

Type of disaster n (%)	N = 83
Mass influx of patients (major accident)	76 (92)
Hospital accident (fire, black-out, security or communication problem)	76 (92)
Infectious problem (e.g.: Ebola, SARS)	65 (79)
NRBC+B+T risks	N = 80
Nuclear/radiologic	14 (18)
Biological	25 (31)
Chemical	27 (34)
Burned	15 (19)
Polytraumatised	46 (58)
Plan designed for specific populations of patients	N = 80
Children	19 (24)
Geriatric patients	12 (15)
Migrants	10 (13)
Reception of Relatives	33 (41)
In charge of the victims' relatives	N = 80
Staff from Emergency department	37 (46)
Staff from Psychiatry department	11 (14)
Staff from other departments	31 (39)
Other	30 (38)
Patients' flow management	N = 80
The flow of daily patients is separate from the disaster's flow	Yes 41 (51)
Type of support used for managing patient's flow in a Daily situation	N = 83
Digital support	67 (81)
Paper	20 (24)
Other	3 (4)
None	4 (5)
Type of support used for managing patient's flow in a Disaster situation	N = 78
Digital support	52 (67)
Paper	56 (72)
Other	6 (8)
None	5 (6)
Hospital access control manager	N = 80
Private security	29 (36)
Police	24 (30)
Other (technical staff)	34 (43)
None	13 (16)
Recall of Additional staff	N = 80
ED's staff	74 (93)
Staff from other departments	71 (89)
Administrative staff	64 (80)
None	1 (2)
Information regarding the plan n (%)	N = 78
Periodic instruction	50 (64)
Hospital web page	49 (63)
Training/simulations	23 (29)
Word of mouth	15 (19)
Pocket card	11 (14)
Internal paper mail	7 (9)
None	8 (10)

Plan activated	N = 80	
Plan activated in last 3 years	Average: 0.53	
Plan tested in last 3 years	N = 80	
HICS activation only	38 (48)	
Simulated patients	33 (41)	
Descriptive cards	27 (34)	
Plan tested ≥1 time /year	Yes 42 (52)	
Plan tested ≥1 time /3 years	Yes 80 (100)	
Presence of a HICS	N = 80	
HICS present	70 (88)	
Leader of HICS	N = 68	
Hospital's board member	38 (56)	
ED medical officer	14 (21)	
Surgery medical officer	4 (6)	
Anaesthesia medical officer	1 (2)	
Specialist according to the type of accident	3 (5)	
Other	8 (11)	
Time needed for HICS to be operational	N = 68	
< 20 minutes	7 (10)	
20–40 minutes	38 (56)	
>40 minutes	23 (34)	
Type of risk treated	N = 78	
Chemical	47 (60)	
Biological	32 (41)	
Nuclear/radiologic	25 (32)	
No decontamination zone	30 (39)	
Readiness of decontamination zone	N = 48	
Time necessary to be operational (min)	Average 40.3	Median 30.0
Decontamination manager	N = 48	
Hospital care staff	26 (54)	
Hospital Technical staff	23 (48)	
Professional firefighters	19 (40)	
Civil protection (FEMA in USA)	1 (2)	
Army (NBC troops)	1 (2)	
Other	10 (21)	
Protection equipment	N = 48	
3M mask and disposable gloves	44 (92)	
Light chemical protective seal (PPE)	38 (79)	
Other	7 (15)	
None	2 (4)	

Figure 1

Figure 1: Awareness of the plan



annexe 1

Annexe 1 Collaborations to elaborate the plan N = 80 (%)	
State	46 (58)
EMS	43 (54)
Firefighters	33 (41)
Nearby hospitals	29 (36)
Police	23 (29)
Country (Swiss)	13 (16)
Army	5 (6)
Civil Protection	3 (4)
None	14 (18)

annexe 2

Annexe 2 Declared incentives for disaster plan's development: N = 80 (%)	
Hospital requirement	45 (56)
State's requirement	39 (49)
Individual initiative within hospital	30 (38)
Future major event in the region	19 (24)
National requirement	6 (8)
National financial support	0 (0)
State's financial support	0 (0)
Other	10 (13)
None	3 (4)