Crisis Management Aspects of Bam Catastrophic Earthquake: Review Article

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ABSTRACT

Background: Bam earthquake was the most catastrophic natural disasters in recent years. The aim of this study was to review different aspects of crisis management during and after the catastrophic earthquake in Bam City, Iran.

Methods: Data needed for this systematic review were collected through searching PubMed, EMBASE and SID databases, for the period from 2003 to 2011. Keywords included earthquake, Iran and Bam earthquake. The data were summarized and were analyzed using Content Analysis.

Results: Out of 422 articles, 25 articles were included in the study. Crisis Management aspects and existing pitfalls were classified into seven categories including planning and organization, human resource management, management of logistics, international humanitarian aids, field performance of the military and security forces, health and medical service provision, and information management. Positive aspects and major pitfalls of crisis management have been introduced in all the mentioned categories.

Conclusion: The available evidence indicated poor crisis management during Bam earthquake that resulted in aggravating the losses as well as diminishing the effect of interventions. Thus, concerning the importance of different aspects of the crisis management and the high prevalence of disasters in Iran, the observed vulnerability in disaster management process should be addressed.

Introduction

Earthquake is a nearly unpredictable natural disaster. According to United Nation's (UN's) reports, during the last century, about 2000000 people were killed due to 1000 earthquakes over 70 countries.[1] Among these countries, China, Japan, Iran, Turkey, India, Chile, Pakistan and Guatemala have been considered as the most disastrous areas, counting for about 80% of all disasters.[2] Iran stands the 6th in the ranking for natural disasters in the world being among the 10 top earthquake trigger zones throughout the world. Nearly 69% of its lands lie over faults. During the past century, 20

earthquakes measuring above 6 on the Richter scale have been recorded leading to 500000 casualties.[3]

The Bam earthquake was one of the deadliest earthquakes that quaked Bam at 5:26 a.m. on December 26, 2003 for 10 seconds measuring 6.6 on the Richter scale. Most of the city and its infrastructures, including city hospitals and Emergency Medical Services (EMSs) were destroyed. More than 40000 were killed, 30000 injured, about 20000 houses ruined and 45000 people were displaced.[4]

Located in the earthquake band, Iran is bound to experience similar events and such a catastrophe was an alarm to raise the need for an applied planning toward driving down the impact of any probable similar disasters. In order to ensure more effective crisis management for potential future disasters, it should be learnt from previous experiences. Many articles published during the years after the Bam earthquake reported the investigations done after such a catastrophic experience, however, a holistic view of the crisis management aspects of the Bam earthquake needs to be presented by synthesizing the available evidence.

The aim of this study was to review the evidence of crisis management during the Bam earthquake through available studies published about this earthquake.

Materials and Methods

In this systematic review, the required data were retrieved from SID, PubMed, and EMBASE databases. Manual searches were also conducted through journals, Yahoo and Google search engines, relevant websites, reference check of articles and other related sources, using the following keywords and their Persian equivalents; Iran, Bam, Earthquake, Islamic Republic of Iran. Articles published between 2003 and 2010 addressing any single crisis management issue regarding the Bam earthquake were also included (Table1). Both observational and interventional studies were eligible to be included in this review. The following items were excluded; Letters to editor, Non-English / Non-Persian articles, presentations in conferences in abstract format, studies directed on earthquake geophysical aspects and case reports.

Table 1: Search strategy of the present study

Row	Databases	Search Strategy	Limitation	Results
1	PubMed	Iran OR Islamic Republic of Iran AND Bam AND earthquake	English articles- Date between 2000-2010	56
2	EMBASE	Iran OR Islamic Republic of Iran AND Bam AND earthquake	English articles- Date between 2000-2010	111
3	SID	[In Persian]Bam	-	257

To assess the quality of reporting of included published articles, strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist was applied (appendix 1). This list subsequently was checked for each article according to the agreement between authors and accordingly the disqualified studies were excluded. Two authors (*SBH and A-AS*) that had enough knowledge and relevant experience, selected crisis management papers from other aspects of earthquake such as clinical and geophysical aspects. Regarding the contents extracted, data were categorized into 7 topics namely; Planning, Human Resources Management, Logistics, International Aids

Management, Military and Security Forces, Health and Medical Services operations, Database and Information Management. Articles were primarily sorted based on the publication date. The retrieved data were summarized in extraction tables and finally, a manual Content Analysis was conducted on the extracted reports. Endnote X5 software package was used for organizing, title and abstract reviewing and identifying duplicated articles.

Ethical Considerations

The Institutional Review Board of the Tabriz University of Medical sciences approved this study.

Results

Out of 424 retrieved publications, 319 ones were excluded from the study due to previously defined exclusion criteria or duplication. Moreover, 80 other articles were excluded from the study, because they were about non-management issues (i.e.: surgical, psychological, medical etc.). Therefore, only 25 studies were processed in this systematic review (Figure 1).[1, 4-27]
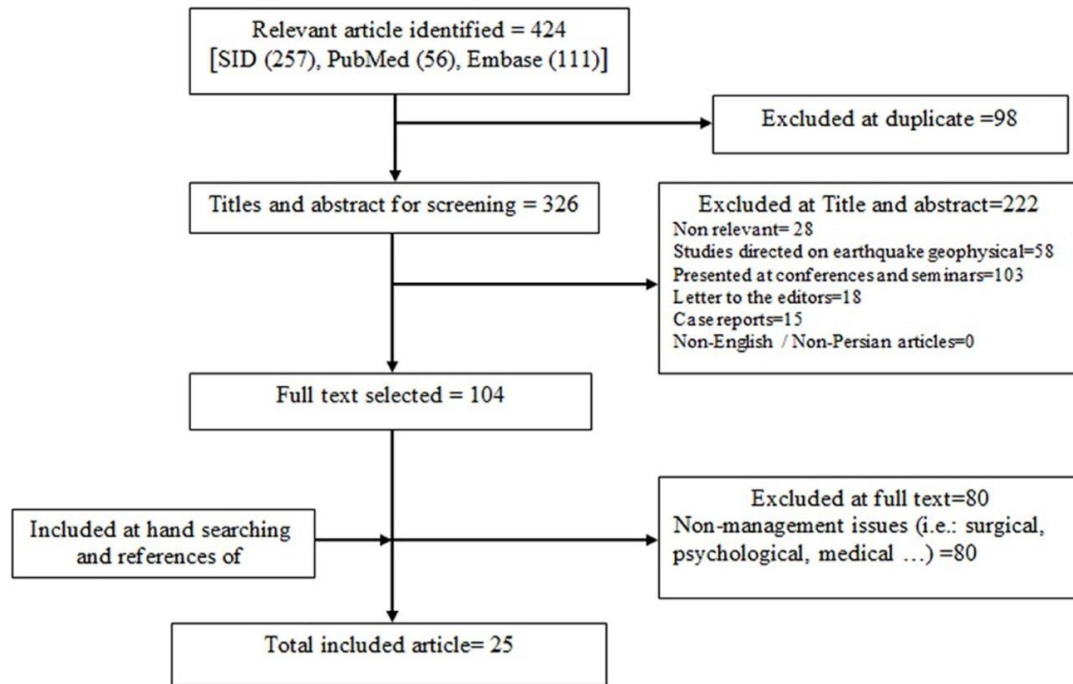
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┌─────────────────────────────────────────┐
│ Relevant article identified = 424       │
│ [SID (257), PubMed (56), Embase (111)]  │
└─────────────────────────────────────────┘
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│ Titles and abstract for screening = 326 │
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              │         ┌─────────────────────────────────────────────────┐
              │         │ Excluded at Title and abstract=222              │
              │         │ Non relevant= 28                                │
              │────────▶│ Studies directed on earthquake geophysical=58   │
              │         │ Presented at conferences and seminars=103       │
              │         │ Letter to the editors=18                        │
              │         │ Case reports=15                                 │
              ▼         │ Non-English / Non-Persian articles=0            │
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│ Full text selected = 104                │
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│ Included at hand  │──▶│ Non-management issues (i.e.: surgical,          │
│ searching and     │   │ psychological, medical …) =80                   │
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│ Total included article= 25              │
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Figure 1: Literature review and retrieval flow diagram

The analysis of information through the review leaded to several categories of results as follows:

Planning

Five out of the 25 studies, indicated poor planning and organizing after earthquake. A cross-sectional study carried out 6 days after an earthquake illustrated that the lack of a predetermined clear management plan had yielded serious difficulties and poor coordination between Health Care Providers (HCP) and Search and Rescue Teams (SRT).[8] Another cross-sectional study argued that the poor planning had resulted in issues and dissatisfactions concerning food supply, maintenance and distribution.[27] A few studies conducted on injured people admitted in Baqiyatollah Clinic and some other hospitals in Tehran, indicated that poor planning in search and Rescue as well as

transfer had resulted in enormous casualties.[23] In a qualitative study from authorities' views, showed many problems regarding poor planning in the identification process, death declaration and burial rituals.[11] Another study considered the poor planning as a responsible factor for rubble mismanagement. Urban and hospital wastes were not segregated and rubble was piled up illogically around different urban areas.[21]

Finally, all mentioned studies and available evidences convey a multi-faceted poor planning and poor organization before, during and after the Bam earthquake.

Human Resource Management

Five retrospective or cross-sectional studies[9, 11,18,25,27] indicated different poor aspects of human resource management including:

1. Lack of previously codified procedures for sending manpower to the affected area;

2. Contradicting and poor announcement of alleged organizations in recruitment of search and rescue personnel;

3. Inconsistency between supplied skills and real needs in the area;

4. Lack of coordination or management systems in charge;

5. Lack of equipment, accommodation and substitute personnel resulting in mental & physical exhaustion of manpower in the area;

6. Poor training for Health Care Providers (HCP) to operate in disaster;

7. Inability in recruiting and organizing international forces.

Logistics

Logistics direction is evaluated based on its different aspects during the Bam earthquake as follows:

1. Alarming Systems:

Most quakes have alarms. Awareness of these alarming signs has historically resulted in driving down casualties. Concerning such alarming signs, two studies described that two minor quakes prior to the Bam's main catastrophic earthquake, were dismissed by authorities, the State Crisis Committees and people. Thus, it is necessary to notify people about any probable incident, using appropriate measures or systems.[9, 19]

2. Search and Rescue measures

The efficient communication with neighboring cities, prompt rescue and incident control, triage and medical emergencies figure among these measures. Most studies carried out in this regard, implied poor search and rescue operations in Bam and an average time of 1 -5 hours lasted for rescuing buried people from beneath the rubble.

These studies reported a significantly long mean time, from 14 to 19 hours, for providing primary therapeutic care.[18, 23, 25] Another article discussed how the first and majority of the rescue measures during the earlier hours had been made by people and relatives.

Finally, search and rescue issues during the Bam earthquake can be briefed as follows:

1. Inadequacy of trained search and rescue personnel;

2. Inappropriate distribution of search and rescue and medical equipment;

3. Unavailability of search and rescue planes and helicopters;

4. Uncoordinated teams working unorganized with each other;

5. The lack of proper hardware and equipment[9, 18, 23-25]

3. Medical Evacuation and Transfer of Victims

Prompt and accurate evacuation and disposition of victims and casualties to hospitals and [other treatment facilities] are accounted as the main measures for cutting mortalities and morbidities during catastrophes.[18,25] A cross-sectional study demonstrated that transfers done bare handed or just using blankets during the early hours after the earthquake leaded to many morbidities and sequels.[24] Available statistics of medical transfers have been rather contradicting. Information on website of Roads and Transportation Office (RTO) announced 5511 transported victims during the 9 days after the quake. Meanwhile, the Revolution Guard's Medical Center announced 7300 transported victims on the first day after the quake.[8] The mean transportation time to the first care center after rescue, varied from 7 to 14 hours, which seems to be remarkably long compared to other studies.[6,18,23] Another study reported that 54% admissions on the 2nd and 3rd days after the quake and discussed that how poor transfer could have contributed in these late admissions.[27] In contrast, with results from various studies reporting the medical air-evacuation transport as the best model, an effective air-transport facility was not settled until the second day after the Bam Earthquake.[23]

4. Food and Medicines

A sufficient medicine supply in the earthquake zone can potentially diminish mortality and morbidity. A review article calculated 3.5 medicinal items consumed for each outpatient individual during the 6-month period after the earthquake.[6] Large numbers of opium addicts suffering from withdrawal due to the lack of access caused some of the main problems during the days after the quake. A study focused on this issue reported that a remarkable rate

of withdrawal manifestation of 50% among 163 including cases in the quarry during the 2 weeks after the earthquake. One third of this population had access to opium on just the first day and two third of them did just over the second day.[12] Most food related dissatisfaction among people was due to inappropriate delivery, lack of diversity and low quality, respectively. Authors delineated poor management and poor supervision as the main reasons.[27] The most frequently used foods during the days after the earthquake were can foods with low quality and low diversity. This had been indicated in Ocha report as well.[7]

5. Camping and Settlement Facilities

Studies revealed an inadequate number of camping and temporary settlement facilities. These inadequate facilities were also not properly furnished for displaced people.[22,25]

In short, the poor logistic management components during the Bam earthquake could be briefed as follows:

1. Delay in sending supply and equipment;

2. Lack of services and gears for rescuers;

3. Incoordination among organizations in charge of providing equipment and resources;

4. Ineffective broadcasting methods to reflect on the logistic demands in the area.

Management of international aids

Though somehow late with unknown reasons, studies recorded international aids from 60 countries. These aids included 7 to 60 rescuers, 4 to 22 physicians, 5 to 200 hospital beds and around 483 search and rescue operations.[7] There were 600 foreign physicians and nurses running 12 field hospitals. The International Committee of the Red Cross in association with the Iranian Red Crescent Organization provided 250 hospital bed services in the area. International services endured for 1 year in the earth-quake-stricken zones.[7]

Military and Security forces Operation

Regarding vast resources, military forces are widely recognized as a proper candidate to take action during disasters.[19] Sufficiently trained people to operate in catastrophes, and independent on transportation communication and supplies, these forces are not a burden on any other system.[6] Both the Revolution Guard and security forces contributed in helping survivors, rescuing and rebuilding devastated area. Their main activities are briefly listed as follows:

1. The first dispatched report, 36 minutes after quake by the Seyyed ol Shohada brigade 1 commandment.

2. Reacting as the head/main forces present in the county to start the search and rescue operation.

3. Running 2 field hospitals in the area.

4. Dispatching 937 HCPs and rescuers to the area.

5. Establishing 23 Emergency Medical Service stations, 13 rescue stations and 8 clinics in the area.

6. Actively contributing in transporting 11492 injured and wounded people.

Health and Medical System Preparedness

In Bam, 20% of all domestic health care providers died due to the earthquake. The Other 80% survivors had either been disabled or mentally freaked. All care centers and the 3 main hospitals of the city had been completely destroyed. Besides, 80% of all hospitals, 85% of urban health centers and 100% of rural health centers were among these destroyed complexes. About 12000 casualties were admitted in suburban hospitals during the first 4.8 hours.[9] Health care authorities succeeded to burn 93% of human corpses after only 48 hours. Most universities of health and medical sciences in the country contributed in disease control, environmental health, mental health, and the health care centers rebuilding program.[6] As a result, there were 792 cases in 3 weeks and upper respiratory infections were the most common medical disease challenge. Mental health programs were widely planned and started for survivors. Environmental health plans including providing and distributing drinking water bottles, rubbish destruction, and sewerage system repair and also disinfecting and testifying the area started on the earliest days. Moreover, 65% of hygienic irrigating systems should have been repaired.[8]

Despite all of the above mentioned implementations, studies showed that the health and medical systems were poor in reaction due to;

1. The lack of a well-defined, integrated and coordinate plan. Health Care Providers (HCPs) and Search & Rescue Providers (SRPs) were confused and their tasks were frequently overlapped.

2. Health and medical forces were not well trained to operate in catastrophic conditions.[8]

3. Poor food supply, maintenance and hygienic quality control.[27]

4. Poor documentation.[14]

5. Providing an insufficient number of standard lavatories and bath.

Broadcasting and Information Management

Databanks and information management systems were found ineffective and inadequate during the Bam earthquake. Reported numbers varied from 25000 up to more than 45000 victims and from 20000 to 30000 casualties. Seismography centers in Iran, the United States and France, announced the earthquake scale as 6.3 to 6.7 on the Richter scale, while the nearest seismography center to Bam measured it as 6.5. Such measurements were differently reported in studies.[1,5,8-10,17,24] Poor data management was obvious in its many different aspects including human resources, statistics about casualties transport, supply and logistic demands, etc. Communication systems including telephone systems were disconnected and caused delayed disaster declaration[6], inadequate recording, increased mortality among casualties transported to the hospitals.[9] International aids were poorly gathered and distributed.[20] A comparative study of news reported by two authentic newspapers showed that such a significant event kept alive only for up to 2 months among headlines of these two newspapers for covering reports.

Discussion

In this study, the status of the Bam earthquake crisis management was assessed through reviewing published articles, for the time between 2000 and 2010. The present review revealed poor crisis management during and [after] the Bam earthquake in all of the classified fields.

A retrospective review study conducted by Kalantar Motamedand et al.,[18] during 2003-2008, concluded that the most prominent Bam crisis management issues included casualty transport, medical supply shortage, inadequate therapeutic plans, the lack of proper task assignments among HCPs, inadequacy of hygienic services. These were all confirming, though the former was mainly designed to evaluate health and medical issues.

During disasters, health or medical organizations figure highly involved and widely effective on mortality and morbidity caused by the disaster. Through our review, we believe that in spite of existing defects, health and medical entities [authorities], including the ministry of health and medical sciences, acted properly in comparison with other organizations involved during the Bam earthquake. Saghafinia M et al.,[28] expressed the same idea in their evaluation of medical management in the Bam earthquake. This might be partly due to the presence of trained or specialist individuals, sufficient financial sources and efficient management in such systems.

Saberi and Qayyum showed that even after educating the medical students on crisis management regarding the Keshmir earthquake, they might not act properly at disaster time. They, therefore, stressed on the role of continuous education in this regard.[29]

The use of information systems could be vital in disaster management especially in the earthquake crisis management. The geographical information system (GIS) could also be of high value in this regard.[30]

As the take home messages, the following points could be reported as main areas of poor performance of crisis management aspects in Bam earthquake:

1-Poor plans codified in advance

2-Poor integrated and organized supply and rescue systems

3- Poor informing systems

4-Non-coordinated activities of authorities in charge of the search and rescue and other operations

5- Mismanagement of international received aids.

Thus, standing among disastrous zones in the world, Iran must specially address eliminating vulnerable aspects of disaster management as a national priority. To achieve this, authors offer the following earthquake-directed adjustments.

The main limitation of this study was although some governmental reports usually prepared by security organizations after natural disasters are considered as valuable sources of information, we did not have access to them, due to the confidentiality of such documents.

Suggestions

A review of various aspects of management based on the comparison of 5 major earthquakes from 2000 to 2010 concluded that the earthquake management system incorporates 15 key components. We believe that the Iran's National Crisis Management system is not exempted from these key components indicated as follows:

1. Timely activation of rescue teams;

2. Training rescue teams according to a standardized curriculum;

3. Establishing emergency medical care at the scene in the first hours after the earthquake;

4. Providing prompt air transfer services for the critically ill victims;

5. Applying the quick assessment and management charts/ forms at the scene by paramedics;

6. Establishing a national on-line data bank to collect and analyze the data;

7. Building quake-resistant structures;

8. Continuous training programs for students in schools and universities as well as general population;

9. Permanent disaster relief team organizations with national and international activities;

10. Developing strategic management plans;

11. More investment to make communities better prepared for disaster and less vulnerable;

12. Volunteer aid recruiting (and educating to prevent harm to victims upon rescue) and training general public to deal with major emergencies;

13. Social organizations should be well organized to participate in assistance;

14. All medical staff should follow a dress coding;

15. Ideally, disaster management should be an essential part of all medical training.

Apart from the above-mentioned requisites, it appears that some other measures are of great importance in Iran, including;

16. Developing earthquake proof structures and developing communicational infrastructures in earthquake trigger zones.

17. Liaison and closer relationship with International organizations including, ICRC, NGOs and volunteer charity institutes.

18. Providing wide public disaster preparedness training programmes, especially in cities close to the earthquake trigger zones.

19. Arranging scheduled drills

20. Rremarkable characteristics of all the 21 mentioned improvements suggested that they could all be classified into four main categories of Operations, Planning, Logistics and (Financing/ Administration). These are exact sections found on Incident Command System (ICS) the ICS Organization flow-chart is widely available to use as seen below (Figure 2);

Such a previously well-defined and practiced model is strongly recommended by the authors to be adopted or duplicated and practiced in Iran.

21. Stabilizing Hospital Incident Command System (HICS) in hospitals. HICS is a method by which the hospital operates when an emergency is declared. Hospitals are often weakly equipped to evaluate the strengths and vulnerabilities of their own management systems before occurrence of the actual disaster. Concerning studies indicating poor HICS in Iran, hospitals should codify and stabilize such systems.

22. Activating a more prominent contribution with the Ministry of Health and Medical Sciences and accordingly its descent resources.

23. Disembarking army and security forces in the earthquake-stricken area might be effective in preventing an administrative issue, which is known as "Resource Diversion". However, addressing the earthquake in Iran as a multi-faceted issue still requires working on all political, moral, technical and other aspects influencing management systems.
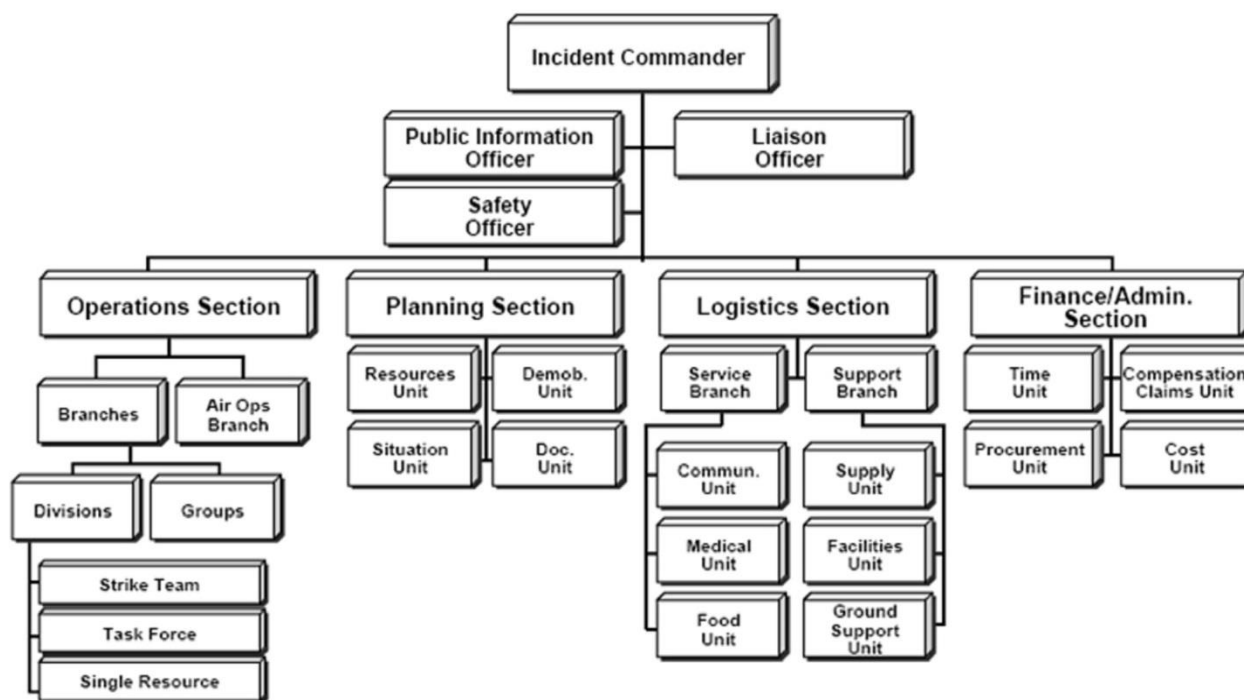
Figure 2: Incident Command System (ICS) structure chart

Acknowledgements

Competing interests

The authors declare that there is no conflict of interest

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Appendix 1:
STROBE Statement-checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls
		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*)*Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed
		Case-control study—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed
		Case-control study—If applicable, explain how matching of cases and controls was addressed
		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Result		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of

Appendix 1: Continued…

Outcome data	15*	(c) *Cohort study*—Summarize follow-up time (eg, average and total amount) *Cohort study*—Report numbers of outcome events or summary measures over time *Case-control study*—Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study*—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarize key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalizability	21	Discuss the generalizability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.