PART I
INTRODUCTION

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Chapter One
INTRODUCTION

ABSTRACT
Disasters continue to increase in frequency and affect more and more citizens of the world community. Economic costs are increasing at an alarming rate. The death toll in the last 50 years has been in excess of 12 million persons, billions of people have been "affected", and economic costs are estimated as high as US$4 trillion. Human and economic costs have been estimated for disasters caused by natural and manmade events. Manmade events are segregated into technological and inter-human conflicts. Defined human costs do not include those effects such as short- and long-term psychosocial problems that cannot be quantified. The lack of structure for the conduct of research and evaluation of interventions impairs our ability to learn from experiences. This Chapter introduces a structural framework for investigations into the medical and public health aspects of disasters including: (1) a standardized, universal set of definitions; (2) a conceptual model for disasters; (3) indicators and standards; (4) descriptions of 14 basic societal functions bound together by a coordination and control function; and (5) a disaster response template and two research templates. The templates are to be used in the design, conduct, analysis, and reporting of research and/or evaluations of interventions directed at preventing hazards from becoming a disaster-producing event, mitigating the effects of such an event on the affected society, and/or responses to a disaster.
Keywords: conflicts, inter-human; costs; disasters; evaluations; events; functions; guidelines; impact; indicators; model; natural; research; standards; structure; technological; templates

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DISASTERS, whether caused by unavoidable natural events or by avoidable, manmade events, always have been a part of life. Although a disaster may be expected, there is some uncertainty as to how and when it will occur. The occurrence of a disaster creates varying degrees of chaos combined with a mismatch between available resources and needs. The restoration of an affected society back to its pre-event status requires extraordinary effort.

Historically, disasters have been considered as punishment from some deity. Today, the attitude toward disasters seemingly is changing, as are our capabilities to mitigate the impact of the events responsible for them. However, the potential to influence the negative outcomes of disastrous events has not been recognized in any standardized fashion. Much of the aid provided has been based on intuition and anticipation, and has not necessarily been rooted in knowledge and understanding.

The impact of disasters on the world community is astounding. In the last 50 years, more than 10,000 disasters have been reported that together have directly affected more than 5 billion people (numbers affected are inflated since many of the same populations have been victim to repeated disasters).[1] The death toll during this period, as estimated from the database maintained by the Center for Research on Epidemiology of Disasters (CRED) and the U.S. Office of Foreign Disaster Assistance (OFDA), has been in excess of 12 million persons. Overall, reported economic costs have been estimated at more than [US]$1 trillion. These data must be viewed with caution as it is not clear how many of the disasters have been reported, and on the average, only about 24% of the reported disasters include economic cost data. Thus, estimated economic costs likely reach as high as [US]$4 trillion. Further, many reports of the occurrence of a disaster have registered the number of people killed, but have not listed the number of persons that were "affected". The discussion that follows uses data abstracted from these databases, to examine the scope of the societal impact of disasters on the world community with particular reference to their medical and public health implications. Adequate and accurate accounting of the damage that is created by the events that cause disasters currently is not possible.

Three additional facts are of increasing concern: (1) Disasters continue to increase in frequency; (2) Disasters are affecting more and more citizens of the world community; and (3) The economic costs associated with disasters are increasing at an alarming rate (Table 1.1, Table 1.4).[1] Given the

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lack of a standardized mechanism for reporting, and the availability of a common, comprehensive database, and the absence of a uniform set of definitions, it must be assumed that the above statistics and those that follow are, at best, underestimates. Nevertheless, the trends are apparent for the majority of disasters.

COSTS

As disasters continue to increase in frequency and affect more and more people worldwide, the costs associated with these catastrophes are multiplying in an uncontrolled manner. The following is a summary of the costs incurred from just one event, Hurricane Mitch:

> Hurricane Mitch was the worst natural disaster in Nicaraguan history, and one of the worst to hit the entire region in decades. Some 3,000 people were killed in Nicaragua and more than 5,000 in Honduras. Some 870,000 people were affected by the storm in Nicaragua (18% of the population), while estimates in Honduras reached 75% of the population affected by the storm. Total damages in Nicaragua surpassed $1.5 billion, while in Honduras, the damages ranged beyond $4 billion. In the region as a whole, more than 9,000 people were killed, 3 million displaced, and $8.5 billion in damages incurred. Hundreds of bridges, thousands of schools and clinics, and kilometers of water systems and roads were destroyed. Agricultural crops sustained severe losses that will take many years to recover.[2]

This one report exemplifies the damage sustained in terms of the number of persons affected or killed as well as to the societal infrastructure. In addition, it provides an overall estimate of the economic impact of the event. It does not include either the psychosocial impact, the loss of the production capacity, or the effects of agricultural production, and it does not describe the disaster that occurred following the precipitating and secondary events, many of which are difficult, if not impossible to quantitate. Thus, the costs of disasters can be described in human, economic, and intangible terms.

Human Costs

Human costs generally are computed on the basis of numbers of persons killed. For example, more than 500,000 persons were killed in Rwanda during the civil war and genocide (1993)[3] (some estimate up to 1 million were killed);[4] an earthquake in China in 1976 consumed at least 255,000 lives (unofficial estimates reach 650,000);[5,6] more than 300,000 persons were killed in Bangladesh in 1970 and another 135,000 in 1991;[1] 25,000 deaths resulted from the 1988 earthquake in Armenia;[7] at least 20,000 persons were reported missing or dead in Latin America from Hurricanes Georges and Mitch (1998);[8] and more than 5,500 persons died from the 1995 Great Hanshin-Awaji (Kobe) earthquake in Japan.[9] From the beginning of 1990 until the end of 2001, at least 70 natural disasters, each responsible for the deaths of more than 1,000 persons, have been registered.[1]

The Center for Research on Epidemiology of Disasters (CRED) together with the U.S. Office of Foreign Disaster Assistance (OFDA), has compiled relevant information obtainable from related governments and organizations within and outside the United Nations (UN) system.[1]

Natural Disasters

Table 1.1 was constructed using the CRED database. Although it seems that the data are somewhat inconsistent and, admittedly, not complete, several observations seem cogent:

1. The number of natural disasters reported has been steadily increasing since the 1950s.
2. The number of *persons affected* by natural disasters has been steadily increasing since the 1950s.
3. Despite the increasing numbers of natural disasters and increasing numbers of persons affected, the number of *persons killed* has been

	DECADES					TOTAL
	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	1951-2000
Number of Disasters	367	717	1,162	2,081	2,985	7,312
Persons Affected	11,176,496	233,704,495	767,985,585	1,453,553,034	2,129,297,606	4,595,717,196
Persons Killed						
N	4,177,884	2,088,942	1,408,749	829,441	754,206	9,259,222
Probability	0.3748	0.0089	0.0018	0.0006	0.0004	0.0020

Table 1.1—Available information on numbers of natural disasters, the number of persons affected and the number killed for all ***natural*** disasters listed by decade from 1951 (N=number; Source: CRED database)

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decreasing. (Thus the probability of being killed in a natural disaster has decreased substantially.)

4. The total number of persons affected by natural disasters in the last 50 years equals about two-thirds of the world's population though many have been affected by more than one event. Overall, the number of persons affected exceeds the number killed by 500-fold.

The relationships between the numbers of deaths and those affected by the disaster vary significantly with the type of event that precipitated the disaster. Table 1.2 is a summary of the data available from the CRED database for four sudden-onset and two slow-onset, natural disasters for the period from 1966–1990 (Table 1.2A) and from 1991–2001 (Table 1.2B). During the period of 1966–1990 (Table 1.2A), 3,020 natural disasters were recorded. These disasters, precipitated by natural events, affected a total of 2.3 billion persons (although many were affected by several disasters each was counted separately), and consumed the lives of 3.6 million people. Not only are there

A

	High Winds	Earthquakes	Floods	Volcanoes	Famine	Droughts	Total
Disasters (N)	1,165	387	1,004	64	20	380	**3,020**
Affected (thousands)	214,846	52,584	784,553	983	22,247	1,235,783	**2,311,000**
Deaths N (thousands)	416	541	126	26	605	1,884	**3,600**
Probability	0.0019	0.0103	0.0002	0.0271	0.0272	0.0015	**0.0016**

B

	High Winds	Earthquakes	Floods	Volcanoes	Famine	Droughts	Total
Disasters (N)	847	244	1,042	60	45	277	**2,465**
Affected (thousands)	276,631	36,249	1,483,232	2,041	38,236	434,785	**2,234,961**
Deaths N (thousands)	208	80	102	0.9	277	3	**671**
Probability	0.0008	0.0022	0.0001	0.0004	0.0072	0.00001	**0.0003**

Table 1.2—Distribution of the numbers of persons affected and killed by type of natural disaster from 1966-1990 (A) and from 1991-2001 (B) (N=number; Source: CRED/OFDA database)

substantial differences in the number of people affected that are characteristic of each event, but the lethality of each event and the probability for being killed when exposed, varies by type of event and between time periods.

Some substantial changes have occurred between the first 25-year period and the last 11 years for the six disasters that are summarized in Table 1.2A and Table 1.2B. The numbers of the disasters by type of precipitating event and the totals, increased substantially as did the numbers of persons affected (1991–2001), almost equating with the totals for the preceding 25 years. However, the number of persons killed, dropped from 3.6 million in the first 25 years to 671,000 over the last 11 years. Viewed together with the increase in affected population, this indicates that the probability of dying, if affected by a disaster, dropped from 0.0016 to 0.0003 (or from 1 per 640 affected to 1 per 3,000 affected, respectively). Thus, although more persons were affected by natural disasters than in the preceding 25 years, these events, seemingly, have become less lethal. This trend in lethality occurred across all six types of the natural disasters analyzed.

The extent to which these changes reflect a natural variation, insufficient reporting, better mitigation and management activity, or a combination of them cannot be determined based on the current data and knowledge. The potential for interference by confounders is substantial. Based on the CRED database, it can be assumed that natural disasters actually are increasing in number and affecting more people, but that the overall lethality is decreasing. But, it is important not to lose sight of the fact that these six natural disasters consumed the lives of more than 670,000 persons in the last 11 years, and due to large data gaps, the mechanisms behind this reduction only can be estimated and only partly understood.

Manmade Disasters

Manmade disasters are caused by hazards that have been created by human activities. Such disasters can be classified either as caused by the development and implementation of technologies that are associated with societal "development," or those caused by inter-human conflicts, such as war, complex emergencies, and terrorism.

Technological Disasters

Technological disasters are those disasters that result from actualization of hazards created by humans, exclusive of inter-human conflicts or complex emergencies. The following example serves as a cogent illustration. On 02 December 1984, a leak of poisonous methyl isocyanate in Bhopal, India resulted in at least 2,500 deaths. Moreover, the event injured 500,000 people of which more than 50,000 remain partially or totally disabled.[11-15] It is important to note that estimates of the numbers of deaths, injured, and disabled vary greatly depending on the data source used: the estimated numbers of deaths range from 2,500 to 16,000, and the number of victims with permanent damage to their health, range from 52,000 to 600,000. The reasons for such huge variations are not clear.

The data summarized in Table 1.3 also have been abstracted from the CRED database.[1] Limitations in reporting are evidenced by the variations as mirrored within and between databases, and also raise some questions as to the validity of the data. During this entire 50 year span from 1951–2000, a total of 3,524 technological disasters have been reported. The incidence of technological disasters has been increasing progressively since the 1950s with the last decade contributing to 61.5% of all of the technological disasters recorded in the CRED database. The number of technological disasters per decade rapidly is approaching the numbers of natural disasters reported (Table 1.1, Table 1.3). The number of persons reported to have been affected by technological disasters has been variable by decade with the highest numbers occurring during the 1970s and 1980s. Despite the increased number of events during the last decade, fewer people have been affected than during the preceding two decades. However, except for the decade of the 1950s, the

	DECADES					TOTAL
	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	1951-2000
Number of Disasters	52	94	289	922	2,167	3,524
Persons Affected N	410,356	98,629	1,906,099	2,262,013	727,628	5,303,725
Persons Killed						
N	8,401	5,577	90,105	66,105	87,648	257,836
Probability	0.0205	0.0565	0.0473	0.0292	0.1205	0.0486

Table 1.3—Available information on numbers of technological disasters, the number of persons affected and the number killed for all ***technological*** disasters listed by decade from 1951 (N=number; Source: CRED)

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probability of being killed if exposed to a technological event, far exceeds the probability of succumbing if exposed to a natural event.

Inter-human Conflict

Inter-human conflicts consist of disagreements between two or more parties that have the potential to inflict harm upon one, both, or all of the parties involved. They include armed conflicts using conventional war methods, complex emergencies consisting of persons displaced from their homes, but remaining within their national borders, or refugees that are forced to move across international borders, terrorism, and unarmed conflicts including sanctions and embargoes. Deaths from conflicts between humans have been responsible for more than 2.3 million deaths during the last 11 years.[11] Despite the inconsistencies between the multiple databases, their use, and interpretation, the number of persons killed by inter-human conflict exceeds the numbers killed from all other disasters combined during the same time period by a factor of more than three. Again, remarkable differences become apparent when examining the available databases. For example, focusing on *major* conflicts (>1,000 killed per year), for the period from 1990 to 1999, the Center for Systemic Peace lists a total of 49 conflicts that, together, resulted in more than 1.3 million people killed.[11] However, for the same time period, the CRED database lists 162 conflicts with more than 1,000 killed, accumulating to the deaths of more than 2.2 million persons. The CRED data are consistent with those of other databases such as those maintained by the Stockholm International Peace Research Institute (SIPRI) and by the Uppsala University Department for Peace and Conflict Research (UDPC).[16-17] However, SIPRI defines major conflicts as conflicts with more than 100 killed per year and UDPC defines major conflicts as those resulting in more than 25 deaths a year. Not surprisingly, since such differences in terms and definitions prohibit structured global research on conflicts, (a problem similar to that in overall disaster evaluation and research) peace and conflict researchers conclude that new sets of data for conflict research must be developed.[18]

Complex emergencies are disasters that are the result of migrations of large numbers of persons, usually due to human conflicts such as war. Inter-human conflicts result in tens of millions of displaced persons and refugees, in addition to the millions of deaths and injuries.[1] Global estimates for the number of internally displaced persons (IDPs) (those displaced from their home, but who remain within their national borders) at the end of 1999 are enormous: the U.S. Committee for Refugees estimated that there were more than 29 million IDPs during 1999.[19] The total number of IDPs actually is greater than is the number of refugees (persons who flee across international borders). Such populations are exposed to new hazards and accrue increased vulnerability to illness and death. In addition, these migrated populations pose a huge strain upon local health resources. Migrations of large portions of populations as well as inter-human conflict constitute a massive public health problem.

Thus, the number of deaths represents only a fraction of the human costs. Thousands of persons are injured physically and/or emotionally as a result of such events, and the effects continue long after worldwide attention has disappeared. Many persons will remain incapacitated for the rest of their lives, including the many children left without families and with terrifying memories and nightmares. The data that are available are diffuse and, currently, it is not possible to quantify the morbidity, both physically and emotionally from such situations. Examples include injuries and deaths from landmines (often of innocent children), divorce rates of rescuers and aid workers following exposure to emotionally disturbing events, suicide rates, alcoholism, drug dependency, non-access to medications, etc. Such costs only now are receiving attention as part of the human costs produced by disasters.

Economic Costs

Accompanying the human costs are astounding economic costs (Tables 1.4 and 1.5). Reported estimates of the economic costs associated with the Kobe earthquake were more than [US]$100 billion,[21] and the impact of Hurricane Andrew upon Florida in 1992 cost more than [US]$26 billion.[16] Payments by the company responsible for the technological disaster in Bhopal to the Indian government for the support of the survivors and the injured totaled at least [US]$470 million.[22-25] Often, the economic costs do not correlate with the number of deaths; for example, while there were only 33 deaths directly attributable to the Northridge, California earthquake, the disaster was the most costly in the history of the United States ([US]$44 billion).[26] Furthermore, reported cost estimates may not include the costs of aid provided or costs associated with loss of production and, thus, do not reflect the total costs. Seemingly smaller losses in a developing country may constitute a relatively large part of its national economy; the damage sustained by

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Honduras and Nicaragua from Hurricane Mitch was higher than the combined gross domestic product of these countries.[16] More than 70% of the crops in Honduras were lost following Hurricane Mitch.[22] The cyclone that impacted Orissa in India in 1999 resulted not only in the loss of 80% of the crops, but also all of the seeds and stored food in some areas.[23]

In the compiled list of world-wide disasters from 1990–2001, the accumulated costs reach [US]$695,080 million. However, out of the 3,437 disasters /events listed, costs were not reported in 2,424 (70.5%), including famines that have affected tens of millions of people. Thus, an estimate of economic

	DECADES					TOTAL
	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	1951-2000
Number of Disasters	367	717	1,162	2,081	2,985	7,312
Costs (million USD)	$6,935	$18,445	$79,855	$189,427	$667,224	$961,896
Disasters w/cost data available N (%)	24 (12.3)	293 (40.9)	364 (31.4)	672 (32.3)	923 (30.9)	2,298 (31.4)

Table 1.4—Available information on the ecomonic costs for all ***natural*** disasters listed by decade from 1951–2000 (N=number; Source: CRED)

	DECADES					TOTAL
	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	1951-2000
Number of Disasters	52	94	289	922	2,167	3,524
Costs (million USD)	$218	$238	$89	$6,951	$20,029	$27,525
Disasters w/cost data available N (%)	2 (3.8)	31 (40.0)	44 (15.2)	82 (8.6)	105 (4.8)	251 (7.1)

Table 1.5—Available information on the ecomonic costs for all ***technological*** disasters listed by decade from 1951–2000 (N=number; Source: CRED)

costs approximates [US]$2.1 trillion for the 11 year period, or an average of [US]$200 billion per year, or $550 million per day.

The reported costs associated with natural and technological disasters for the last five decades are summarized in millions of US dollars in Tables 1.4 and 1.5, respectively. Unfortunately, costs have been reported only for an average of 31% of the reported natural disasters and only 7.1% of the technological disasters. However, those reports that have costs included, demonstrate a progressive and profound increase across the five decades for both the reported natural and technological disasters. Even given the limitations imposed by the lack of reporting of the financial costs, the economic costs are astounding and may total [US]$3–5 trillion. And these costs do not include costs associated with inter-human conflicts/complex emergencies.

As demonstrated in Table 1.6 (A and B), availability of data regarding costs varies enormously between the different types of events. Data regarding the economic costs associated with famine seem to be the most difficult to quantify. The greatest numbers of reports that contain cost data have been

A

	High Winds	Earthquakes	Floods	Volcanoes	Famine	Droughts	Total
Disasters (N)	1,165	387	1,004	64	20	380	**3,020**
Costs (million USD) N with costs (%) with costs	$75,762 527 (45.2)	$100,001 94 (50.1)	$64,069 362 (36.1)	$2,906 14 (21.9)	$0.05 1 (5.0)	$22,837 87 (22.9)	**265,575 1,084 (35.9)**

B

	High Winds	Earthquakes	Floods	Volcanoes	Famine	Droughts	Total
Disasters (N)	847	244	1,042	60	45	227	**2,465**
Costs (million USD) N with costs (%) with costs	$171,540 411 (48.5)	$211,000 84 (21.7)	$240,841 369 (36.8)	$657 10 (16.7)	$93 2 (4.4)	$31,576 57 (25.1)	**$781,576 833 (33.8)**

Table 1.6—Distribution of the numbers of disasters and the reported costs of disasters including the number and the percentage that have available data on costs by type of natural disaster from 1966-1990 (A) and from 1991-2001 (B). (N=number; Source: CRED/OFDA database)

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for high winds and earthquakes, although the proportion of earthquake reports with cost data decreased during the last decade. Given the reported data, the costs for all except for volcanic eruptions have increased, with the costs in the last 11 years far exceeding those for the previous 25 years.

Intangible Costs

Other associated costs are intangible, and their value cannot be estimated in quantitative terms. They include the loss of confidence in governments, fear for security, and loss of trust in fellow human beings. Recall the concerns generated by the 11 September 2001 attacks on the World Trade Center and the U.S. Pentagon.

Shortcomings

Numerous efforts have been made by various organizations to draw attention to the costs of disasters. The basic concepts expressed by each are repetitive and indicate that little progress has been made. And although the United Nations recognized the increasing impact of disasters on the world's population and environment by declaring the 1990s the "International Decade for Natural Disaster Reduction" (IDNDR), at the end of this decade, one must question the impact of this Declaration.[24] The likelihood of dying in a disaster did decrease during the 1990s, but the number of persons affected and the costs have increased profoundly. Can such an increase be attributed to any conceived institutionalized, manmade influence?

Disaster reporting has improved substantially during the last decade. However, the insufficiencies that hamper disaster research also are evident in each of the referenced different databases. Part of the problem may lie in the confusion between the definitions of precipitating events and the disasters that accompany or follow such events. Both earthquakes and famines are listed as disasters in the databases even though an earthquake is a natural phenomenon that may or may not provoke a disaster, whereas famine already is a disaster and may have different causes.[25] Hazards, incidents, processes, and other factors that lead to or constitute a disaster must be classified accordingly. Sorting in accordance with proper definitions will help to improve the informative potential of these databases.

Further, it is unclear as to what has been meant by "affected" in the various databases. Is "affected' used to define the number of persons injured physically or emotionally, the loss of loved ones or the losses of their homes

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and belongings, the inability to travel or receive essential supplies due to fractured infrastructure, inadequate supplies of potable water and/or food, fear for another forthcoming event, lack of security, or the inability to carry on "normal" daily activities?

Thus, there is a need for a structure that facilitates gathering of accurate data and information in a manner that is consistent, uses commonly agreed upon definitions, and promotes comparisons. Without such a structure and a conceptual framework into which the data are placed, data merely remain data, and the conversion of data into important information that promotes the prevention of future events or mitigation of their effects, should they occur, will not be forthcoming.

OTHER FACTORS

Many factors other than those discussed above, have a profound influence upon the occurrence of events and on their effects should one occur. Currently, it is not possible for human actions to change the risks for the occurrence of natural events. However, it is possible to alter the damage created by such events upon a society or its environment. The risks for the damage created by a naturally occurring phenomenon may be augmented by human actions. Deforestation may promote flooding and/or mudslides, or on the other hand, drought. Earthquake-resistant buildings can result in profound attenuation of the damage sustained from earthquakes.

Unlike natural phenomena, both the hazards and risks associated with development can be modified by human actions. The "development" of societies may produce new hazards and the risk of them turning into an event. Construction of a dam over a fault line may result in cracking or collapse.[26] Landslides into dams have caused enormous flood waves downstream from the dam. The latter occurred in Vaiont, Italy in 1963, killing approximately 2,000 people.[27]

Moreover, as stated in the San Jose Declaration of the Pan-American Health Organization, disasters tend to affect most those persons "who are most vulnerable due to socio-economic factors, such as poverty, which is, at the same time, both a cause and an effect of disasters".[28] Poor constructions increase vulnerability to earthquakes and high winds. The different outcomes from the earthquake in Armenia in 1988 (magnitude 6.9 on the Richter scale; 25,000 people killed) and the earthquake in Seattle in 1999 (magnitude 6.8 on the Richter scale; zero killed) can be attributed to differences in building codes and practices. Huts erected on deforested hillsides are highly vulnerable to mudslides. As exemplified by the Bhopal tragedy, inadequate security and industrial safety codes may lead to catastrophe.

NEED FOR STRUCTURED EVALUATIONS

Without structured and objective evaluations of the responses and measures taken to prevent or mitigate the effects of events resulting in disasters, it is not possible to learn from experiences. Understanding and acting on the lessons learned are essential to optimize the resilience of a society to absorb the energy released by an event and the responses to such events. But, in general, successful, efficient, effective, and beneficial indicators or measures have not been codified and applied to subsequent responses. Important information is lost, errors and inefficiencies are perpetuated, and, in many settings, vulnerability continues to increase. Often, the impact of an intervention is assessed by *quantifying the output and not the outcome*. It is clear that some relief and assistance efforts not only are ineffective in meeting defined needs, but actually are counter-productive and impair potentially beneficial responses and measures. More than 50% of the medical supplies sent to Bosnia during the recent conflicts not only were inappropriate or useless, but also cost the Bosnian government 34 million dollars to dispose of them.[29]

The above discussion leads to the conclusion that there is a need for standardized, objective evaluations of the interventions applied in dealing with disasters. Such interventions may be directed at preventing disasters, mitigating the damage from the occurrence of an event, and/or examining the value of the assistance/aid provided to those affected by the event.

Thus far, there has been little organized evaluation and research into the medical aspects of disasters. For example, the reports from the March 1999 Pan-American Health Organization (PAHO)/United Nations Meetings in Santo Domingo identified issues that arose with the impact of Hurricanes Georges and Mitch that ravaged parts of Latin America in 1998. These reports proposed solutions to some of the perceived problems so that, hopefully, they would not remain problems in future events. Unfortunately, the report contains little actual data obtained from studies. The information primarily consists of reports from persons who experienced the problems and the development of consensus by groups of "experts" concerning the weaknesses and strengths of what occurred as a result of these storms.[30] Most of the issues and the solutions defined represent a litany that has been repeated over and over in after-action reports during the last 25 years. Generally, such evaluations neither have provoked changes nor facilitated identification of the resources required to effect the proposed changes.

Today, there does not exist any universally accepted, organized methodology for the conduct and reporting of the evaluations of the medical efficiency, effectiveness, efficacy, and benefit:cost relationships of disaster medical responses and relief efforts or for the impact of changes created in the resilience of the populations at risk. In addition, there are no standardized guidelines for the conduct of research relative to the health aspects of disaster responses. Research designs and evaluation strategies historically have been anecdotal, and much of the data reported has little external validity (application to other events) because no common factors have been identified — no two disasters, natural, human-caused, or mixed, are exactly alike. In addition, by necessity, both the responses and their evaluation projects are multidisciplinary, and there are no universally recognized, common definitions of terms and abbreviations used among the multiple disciplines involved in reporting the results.

All of this has led to recent developments in the evolution of the new science of Disaster Medicine. There now are techniques available that can be used in the design and conduct of evaluations and research of disasters. The validity of such techniques has been demonstrated repeatedly within the last decade.[8,31-34] Thus, the science to conduct necessary studies currently exists, but a structure into which to fit such studies does not exist.

PURPOSE

The Guidelines presented in this document propose a structural framework for investigations into the medical and public health aspects of disasters that could be used to appropriately design, conduct, and report findings of evaluation and research. Studies incorporating this structure could investigate the resilience and preparation for the impact of the unfortunate release of a hazard, the effectiveness and efficacy of the responses as they relate to the needs of the affected population, and/or benefit:cost relationships associated with responses to disasters worldwide. Studies also could address questions related to hazards and risk modification and prevention. Studies performed using this structure should result in the ability to compare and integrate the findings of the evaluations and research of many disasters with the endpoints of improving the effectiveness and decreasing costs associated with the health aspects of the prevention, vulnerability, preparedness, and responses to disasters. Evaluations and research are designed to enhance the efficiency, effectiveness, and/or benefits of such activities and should be viewed as efforts at continuous quality improvement and not exposure or punishment. The perception that evaluations may uncover some aspects of projects that did not accomplish their intended objectives, creates fear of exposure and loss of future support and prevents many organizations from submitting to evaluations of their efforts. This especially is the case when such evaluations are conducted by evaluators who may have conflict of interest. Evaluations are essential for progress and only are a means for enhancing future efforts and not for criticizing past efforts. Evaluations result in feedback to be incorporated into understanding and future planning.

OBJECTIVE

Disasters and events that result in multiple casualties provoke humanitarian responses to assist the affected population. Today, most of these responses conclude without evaluation of their respective effectiveness in meeting the actual needs of the population receiving the assistance. The principal objectives of disaster evaluation and research are to minimize the probability of the occurrence of a destructive event and to reduce the likelihood of damage from future events. Therefore, it is essential that carefully conducted and reproducible evaluations of the medical aspects of disasters be conducted.

According to Øvretveit:

> Evaluation is attributing value to the evaluated by gathering reliable and valid information about it in a systematic way, and by making comparisons, for the purposes of making more informed decisions or understanding causal mechanisms or general principles.[35]

The overall objective for the use of these Guidelines and the Templates embedded within them is to attenuate or eliminate disasters. This could result from eliminating hazards, decreasing the risks for the actuation of the hazard, augmenting the absorbing and buffering capacity of the society and environment at risk to prevent the hazard from becoming a destructive event, and enhancing the efficiency, effectiveness, and cost:benefit relationship of preparedness and responses to the disaster.

THE GUIDELINES

This report is the result of extensive research and discussions by a Steering Committee during multiple successive meetings in Pittsburgh, Pennsylvania

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USA; Geneva, Switzerland; the Utstein Abbey, Stavanger, Norway; the Nordic School of Public Health in Gothenburg, Sweden; the University of Wisconsin-Madison, Wisconsin USA; Oslo, Norway; and Osaka, Japan over a course of eight years, and by invited participants in an *International Workshop on the Quality Control of Disaster Management* conducted at the Nordic School of Public Health in Gothenburg, Sweden 06–09 March 1997, and again in Lyon, France, 13–14 May 2001. Also included is information obtained from the Gothenburg Working Group through multiple queries conducted via the mail (post) and the Internet. The task was the development of a structural framework for investigations into the medical and public health aspects of disasters that could be used as a guideline for the appropriate design, conduct, and reporting of evaluation and research into the medical aspects of disasters.

The Guidelines and Templates that follow focus on the investigation into the health aspects associated with disasters. However, modified versions of these Guidelines can be designed for the evaluation of the effects of non-medical interventions.

CONCEPTUAL FRAMEWORK

Three major impediments influence the conduct of research and evaluations of disasters:

1. The lack of uniformly accepted, standardized definitions regarding disasters;
2. The lack of a conceptual framework to provide a structure for the study of disasters; and
3. The lack of an endorsed set of indicators for the evaluation of specific aspects of disasters.

Definitions

Definitions vary according to who is studying the topic and the discipline to which the persons conducting the study belong. Although the definition of a disaster as provided through the Disaster Dictionary of SWA Gunn[36] is gaining wider acceptance, there still does not exist one single definition of a disaster that generally is accepted.[37] While the Dictionary provided by Dr. Gunn represents a huge step forward, it primarily is directed to field work, and, as such, does not cover entirely all the requirements for structured research. Thus, a Glossary of Terms that combines definitions from multiple sources, is provided. Hopefully, these definitions will become more widely accepted by the multiple disciplines involved, especially those interested in the medical and

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public health aspects of disasters. Important definitions used in describing disasters were examined, and when they seemed inadequate, ambiguous, or confusing, the definitions were refined. For several terms, it is noted that no definitions existed, and, thus, new ones are provided. Many of the definitions are developed with specific regard to the objectives of these Guidelines, and research conducted with reference to these Guidelines is obliged to incorporate these terms as defined in the Glossary.

Conceptual Model

The Conceptual Framework provides a basis for evaluating the status of a basic societal function and the elements that comprise it, using the pre-event status of the function or element as the baseline. It establishes the requirements for identifying appropriate indicators of the level of function. Further, the discussion examines the differences between the requirements, needs, supplies, and demands of the affected population. A model (including a formula), provided in the Conceptual Framework, examines the factors involved in creating damage from an event. It identifies factors that comprise a conceptual basis for the evaluation of proposed interventions or implemented activities as they relate to the probability of damage resulting from an event.

The Conceptual Framework also provides a structure for the examination of responses to a disaster including relief activities and efforts towards recovery of the pre-event status, as well as for evaluation of interventions in terms of efficiency, effectiveness, outcomes (benefits), and costs. Lastly, the framework examines some of the ethical issues that play a role in disasters.

Indicators

The development of sets of indicators most useful in the conduct of the study of disasters will result from the design and implementation of studies. Although a preliminary set of minimum standards for disaster responses do exist (Sphere Project),[38] only a few indicators exist for the identification of the status of health and healthcare of the affected population. Many of these standards and indicators lack proper substantiation. The selection and validation of appropriate indicators are discussed in detail, and a compilation of many of the indicators that apply in the context of these Guidelines is provided in the Appendices.[1] Hopefully, the inventory of possible indicators and their degree of validation for specific investigations will be supplanted as a result of the use of these Guidelines.

Basic Societal Functions (BSFs)

Fourteen basic societal functions are presented along with the integration of activities provided by a Coordination and Control Center. Distinctions are drawn between medical care and public health functions. The Guidelines stress the interdependence of the societal functions. All functions in a society are interdependent on each other. Dividing society into 14 separate, but interdependent BSFs has been done exclusively for the purpose of structuring research and evaluation, and reporting.

Disaster Response Template

Disasters, their subsequent management, and the mechanisms that inflict damage and influence the outcome from the intervention applied, have been separated into phases that should facilitate application of the results of the studies conducted, and, thereby, the coordination with the findings of other studies. These phases are defined chronologically according to their qualities. For example, Phase A of an earthquake that lasts only 10–60 seconds can be compared to Phase A of a drought that lasts for months or even years. Additionally, an earthquake event that lasts for a very short time can be compared with high winds that have a longer duration, by using defined phases that are not time related. Such structure is essential if cross-correlations of findings are to be accomplished.

Research Templates

Lastly, the document provides guidelines for the design and conduct of evaluation-research. It uses two templates for its structure: 1) An Evaluation-Research Template; and 2) A Project Design Template. These Templates are provided as guides to those interested in developing a project, as well as guidelines for reporting (and publishing) the results of the project.

SUMMARY

The science of Disaster Medicine, although still very young, allows us to make small but significant steps into the understanding of the pathophysiology[i] of disasters. Much of what already has been discovered has been applied

[i] Pathophysiology (Greek) is a frequently used term in human medicine, but also applicable to a society described as a living entity or organism. It comprises two words: (1) patho which means disease; and (2) physiology which is the science of living organisms and their function.

and has changed the way we prepare for the occurrence of the precipitating and secondary events and for our responses to them once they do occur. Use of the Guidelines that follow should enhance further, the utility of what is studied so as to increase our knowledge and enhance our ability to cope with hazards, events, and the disasters that may result.

The Guidelines and Templates that follow focus on the investigation into the health aspects associated with disasters. However, modified versions of these Guidelines can be designed for the evaluation of the effects of non-medical responses. The Guidelines provide methods for the standardization of evaluations and research of the medical and public health aspects of Disaster Medicine. It is a dynamic document that must be validated and modified with field experience and testing.

Four pillars of importance to support the "Table of Research" can be identified: (1) the Conceptual Framework comprises standardized definitions and concepts necessary to minimize confusion; (2) Scientific methods comprise methods validated by the social sciences and applied to disaster research and evaluation; (3) An inventory comprises a list of the basic societal functions as well as the potentially appropriate indicators of change

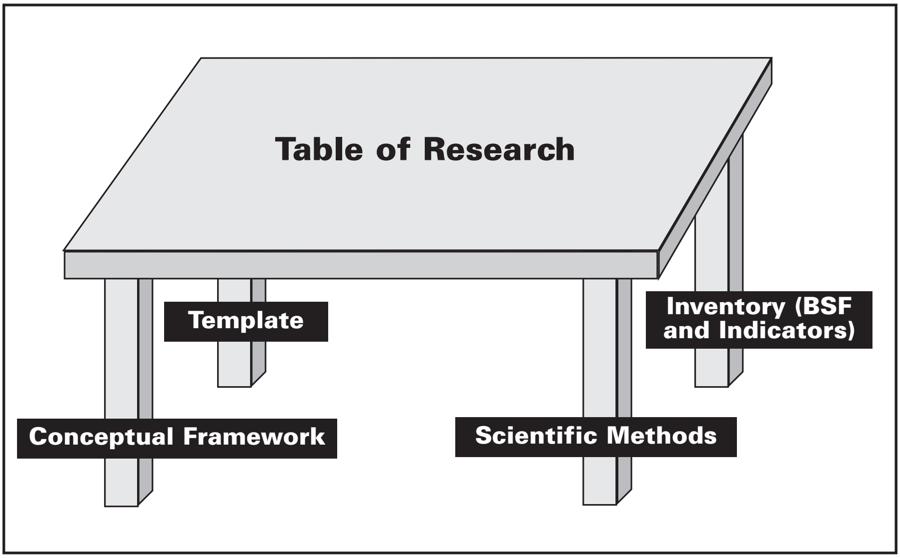

Table 1.1—"Table of Research" supported by its four pillars consisting of the Template; Conceptual Framework; Scientific Methods, and Inventory list of basic societal functions (BSF) and indicators

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from pre-event baselines; and (4) A Template identifies chronological phases and functions that should be incorporated into the structure of research and evaluation projects.

All of these components are provided in this document. It is our hope that each one of these pillars will be as strong as needed to support its tasks.

It is recognized that many models for conducting research and evaluation research will evolve as the science of Disaster Medicine matures. However, it is essential that the scientific community agree to the structure provided in this document. Uniform reporting of the findings using such models will contribute to our knowledge in a way that will enhance the validity of the findings. Applications of the new knowledge will be integrated into the changes needed to better cope with the hazards and events that produce disasters, and will improve our ability to respond to them when they do occur.

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