The Needs of Children in Natural or Manmade Disasters

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A.C. Argent, N. "Tex" Kissoon

Introduction

Disasters have been described as "events of sufficient scale, asset depletion, or numbers of victims to overwhelm medical resources" [1] or as "a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses that exceed the ability of the affected community or society to cope using its own resources" [2]. Importantly, that definition goes on to state: "A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk."

Disasters may occur in many forms (Table 32.1); in different settings and levels of complexity; with variable amounts of warning and very different consequences for people. The number of natural disasters have increased in the last century and doubled within the last 30 years, with many more people affected. During the same period the proportion of disasters that are manmade has increased from 16.5% in the 1970s to 42% in the 1990s (not including "complex emergencies") [3]. As the density of population across the world increases (related both to population growth and increasing urbanization) it is likely that the frequency and impact of disasters will continue to increase. Climate change (with associated extreme weather conditions; change in regional weather and associated change in distribution of pathogens and vectors) is likely to exacerbate this trend.

Increasingly, plans are being put in place to cope with disasters [2]. Sadly, many of the most devastating disasters in recent times have taken place in poorer countries

A.C. Argent (✉)
School of Child and Adolescent Health, University of Cape Town; and
Paediatric Intensive Care, Red Cross War Memorial Children's Hospital, Rondebosch, Cape Town, South Africa

Antonino Gullo et al. (eds), *Intensive and Critical Care Medicine.*

Table 32.1 Disasters and their causes

Causes	
Human	Mass shooting Terrorism War Genocide Building collapses Dam collapses (may be precipitated by severe weather conditions or earthquakes) causing flooding Fires Chemical, biological, radiological and nuclear contamination may occur both deliberately and accidentally
Infective processes	Pandemic infections (such as SARS and influenza, etc.)
Natural	Bush fires Wildfires
Extreme weather	Floods Blizzards Heat waves Hurricanes Tornadoes Cyclones Droughts and famines
Earth related	Earthquakes Volcanic eruptions Tsunamis
Geographical	Mud slides Gas eruptions Avalanches

with limited resources to plan for or recover from disasters. [4]. On the other hand, the international capacity to assist in these settings has substantially improved [2].

Children are at particular risk in nearly all forms of disasters; this is reflected in the excess pediatric mortality in events such as earthquakes and tsunamis. They are at risk for a multiplicity of reasons including: physiology and anatomy (Table 32.2); behavioral stages, organization of schools and educational facilities, pre-existing problems such as technological dependence or illness, and adult behavior. Their vulnerability is compounded by the limited capacity of most health systems to deal with increased numbers of children in need of acute care [5]. Moreover, while acute needs are important, longer-term public health problems are frequently far greater in magnitude and potential impact on health. As an example, in the recent earthquake in April 2009 in Italy, approximately 295 people were killed, 1,000 were injured, but

Table 32.2 Special needs of children

Anatomy and physiology	Consequences	Implications
Cardiovascular physiology		
Low blood volumes and limited cardiac reserve	More liable to: consequences of vomiting and diarrhea (either infective or chemical) Consequences of limited water availability	Need for oral rehydration resources
	More susceptible to dehydration and have limited reserve	Increased need for intravenous access and therapy
	Very limited reserve for blood loss	Need for rapid control of hemorrhage
Respiratory physiology		
High oxygen consumption	More vulnerable to airborne toxins (sarin or chlorine) or pathogens such as anthrax (in context of chemical or biological attack)	More services may be required. May need different gas masks and filters
Limited oxygen reserve High respiratory rate Breath gas at lower levels because of being smaller		
	Many toxic gases are heavier than air, so children are more exposed than adults In nuclear contamination, radioactive material may be at lower levels	Increased need for environmental ventilation and monitoring
	Higher susceptibility to CO poisoning	Increased care with heating and power sources after incident
Skin		
High surface area and permeability (particularly infants <6 months of age)	High absorbance of toxins (chemical and radioactive) that are absorbed via skin	Special needs for pediatric decontamination
Rapid heat loss	Rapid heat loss	Increased needs for warming and environmental control

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Table 32.2 *Cont.*

Anatomy and physiology	Consequences	Implications
Relatively poor keratinization	More liable to abrasion, burns (thermal and chemical)	
Musculoskeletal Limited strength and speed	Limited capacity to escape from danger and harm	
Softer bone structure	Increased damage from falling masonry, etc. Different injuries to adults	Significant needs for pediatric orthopedic services. Equipment required for stabilization and treatment of fracture may be different
Nutrition Extremely limited nutritional resources (particularly in small infants)	Children cannot cope for long without food and water intake	Systems required to provide appropriate food supplements for children rapidly
Different nutritional needs to adults Require assistance with feeding		
Pharmacology Routes of administration of medication	Smaller children are not able to take tablets	Medication (e.g., required in nuclear event) must be available in form that can be taken in appropriate dosage by children
Susceptibility to toxins	Children may be more susceptible than adults to short-term toxins (e.g., organophosphates) as well as radioactivity	Increased attention to protection from toxins

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Developmental and psychosocial issues Age and individual dependant	Limited capacity for self care in the aftermath of a disaster	Resources required for basic care and not just medical care
Children are often grouped in areas away from parents (schools, etc.) guardians	Small children may not be able to provide information about identity and place of origin	Systems must be in place to identify children and ensure that they are kept together with family or
	Psychological consequences of disaster will depend on age and development stage	Appropriate structures required to provide psychological and social support over a period of time
Remain vulnerable to dangers in the environment including abusive adults	May investigate dangerous items or areas as part of curiosity and ignorance	Need to address environmental safety post incident Protect from abusive adults
Infection control	Children will have limited immunization	In mass relocalization situations infectious disease interventions are required to prevent development of epidemics (including immunization programs)
Children with special needs	Dependency on technology which may be affected by the disaster	Range from nebulizers to ventilators

55,000 people were left homeless (http://earthquake.usgs.gov/eqcenter/eqarchives/significant/sig_2009.php). While there was a surge in demand for acute medical services, additional resources are required to meet the specific needs of children including: prevention of infectious diseases; creating safe environments; dealing with the psychosocial aftermath of the events, and recreating appropriate educational and training facilities.

Not only are children caught up in general disasters, but they are sometimes specifically involved in tragedies that affected institutions where large numbers of children were grouped together in schools (as happened in China in 2008). Some mass casualty events have even been specifically targeted at children. As reviewed by Rassin et al. [6] there have been a number of attacks that have specifically targeted schools and nursery schools across the world, resulting in significant mortality and morbidity among children at those institutions.

Although many disaster plans make provision for the care of vulnerable sectors of the population, relatively few plans are specifically geared for the needs of children and particularly for children across the full range of developmental stages. Unless those needs are specifically addressed in the planning for and organization of disaster relief, it is inevitable that children will suffer unnecessary harm.

The Particular Needs of Children

Some of the reasons for the vulnerability of children in disasters are outlined in Table 32.2. Children are vulnerable at virtually all phases of disasters, and it is important to highlight both their specific needs and the skills and resources that are required to fulfill those needs at various stages [7].

Death and Injury

In the acute phase of physical disasters such as tsunamis and earthquakes, children have been particularly vulnerable to death and injury. With limited strength and capacity to flee and/or find shelter from danger, mortality has been particularly high in young children in these events [8]. In a survey of mortality in the Aceh province of Indonesia following the 2005 tsunami, the age-specific mortality in the age-group of children 0–9 years was 19.8%, which was higher than all other age groups other than >70-year-olds. [8]. In eastern coastal areas of Sri Lanka, the mortality among children (during the same tsunami) aged less than 5 years was 31.8%, vs. 23.7% for children aged 5–9 years and 7.4% for adults aged 20–29 years ($p<0.001$) [9]. At a Red Cross Field Hospital in Kashmir in 2005, 145 (45.9%) of patients attending for emergency care were under the age of 14 [10].

In the 1985 gas explosion disaster in Bhopal children were particularly affected by gas inhalation, aggravated by the tendency of many toxic gases to gravitate to ground level. Children were also less able to use clothes or other methods to limit

their inhalation of toxic gases [11].

The pattern of injury suffered by children in physical disasters has also differed from those of adults. Commenting on their experience in Pakistan, Laverick et al. [12] noted that children often presented with scalp injuries and Le Fort facial fractures as if they had been looking up when the masonry began to fall on them, instead of protecting themselves by lying face down (as the adults did).

The care of children in acute disasters may be considerably complicated when parents have been killed or injured, or when children have been separated from their parents. Apart from the psychological trauma of separation, consent for procedures and ongoing care is also problematic [13].

Even after the acute phase of a disaster children remain more at risk for injury in the "damaged environment." Following Hurricane Katrina one team commented on the higher rates of injury for children saying: "The most common injuries in children were lacerations and punctures caused by debris. Several children were bitten by animals, many of which were stray pets with unknown rabies status. Many of the wounds were infected, likely because clean water and antibacterial ointment were unavailable. Cellulitis resulting from insect bites was also particularly common in children." [14].

Disasters Involving Chemical or Radioactive Contamination

Children may be particularly susceptible to injury from disasters involving chemical or radioactive contamination (Table 32.2). While rapid decontamination is ideal, decontamination of small children may pose challenges both to healthcare workers and to the children [15] and there are no existing tested and proven guidelines [16]. Children are also at higher risk of hypothermia (Table 32.2) and small children will require considerable assistance in the process of decontamination. As children may be accompanied by their parents, pediatric facilities should ideally have the resources to decontaminate accompanying parents [15].

Guidelines for chemical and radioactive material decontamination are available in many centers [17,18]; although some protocols have been suggested [16], there is a need for altered protocols that reflect pediatric needs [19]. Unfortunately, few centers are adequately equipped to decontaminate large groups of children in terms of facilities; appropriate washing environments to ensure adequate privacy, temperature control for small children, and adequate numbers of trained and equipped staff to decontaminate large numbers of small children [17]. This is particularly true in the developing world where industrial chemical accidents are probably more likely.

Infection

In general, children and especially infants are more susceptible to infection than adults. Thus children may be afflicted as part of a widespread infective process (possible influenza epidemic) but they may also develop infections in the environment that develops subsequent to a disaster. Ligon [20] and Watson have recently reviewed

Table 32.3 Phases in a disaster

Phase	Issues	Essential activities	Organization required
Planning	Recognition of the risk for disaster and the events which are more likely in that setting		Particular organization of children's services Organization of schools and children's institutions
Warning	Communication of situation to affected people	Safe evacuation of people	Transportation required for groups of children
		Maintenance of law and order in evacuated areas	Management of accommodation, with emphasis on ensuring safe accommodation for children . Communication systems to put children in contact with parents
Initial impact	The immediate consequences of the event with large numbers of injured people, people at risk of ongoing injury, limited resources available to intervene	Rescue, resuscitation, stabilization, and emergency care (for both physical injuries and psychiatric problems)	Needs assessment Establishment of control centers Establishing communication systems Management of "surge in pediatric medical services"
Secondary phase	Dealing with ongoing load of medical requirements.	Provision of "normal resources" such as clean water, power, warmth, shelter, etc. to large groups of people	Ongoing needs assessment
	Starting to stabilize the physical environment	Management of displaced people and animals Management of dead bodies (if at all possible attention should be paid to enabling private rather than mass burial)	Bringing available resources to the appropriate areas Provision of appropriate food for children of different ages

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Table 31.3 *Cont.*

		Stabilization and securing of environment (unstable land, masonry, exposed electrical cables, gas leaks, water leaks) Provide ongoing medical care Establishment of law and order	
Subsequent phase with	Large groups of displaced people and problems of infection control and nutrition	Prevention of communicable disease (clean water provision, sewerage and waste disposal systems, immunization) Provision of food	Maintenance of supply chains Establishment of more sustained systems to stabilize the affected area Immunization programs for children
Rehabilitation phases	Dealing with the long-term consequences of the disaster in that community (much of the psychiatric and rehabilitation data in this section)	Economic redevelopment Social redevelopment Repair of infrastructure	Decisions regarding viability of restoration or alternative plans

the infectious diseases that may be problematic following disasters. Often the environment following a disaster may be highly contaminated (toxins, sewerage, dead bodies, etc.) with limited access to clean water and frequent overcrowding of survivors. In that context infections spread via hands are particularly frequent unless particular attention is paid to hand washing. Many survivors may have wounds, which again have risk of being contaminated, either during the incident or soon thereafter. Meticulous cleaning of wounds and debridement of devitalized and infected tissue is particularly important. This may be difficult to achieve with limited pediatric services.

Respiratory infections may be more frequent in conditions following disasters. Children may be particularly vulnerable to viral infections, and also to infections such as tuberculosis when crowding exists. Every effort must be made to ensure that patients with known tuberculosis receive ongoing therapy, and if possible are kept away from children.

Gastrointestinal infections (including hepatitis) are a particular problem in the context of limited water and sewerage disposal facilities. Children are particularly vulnerable to gastro-enteritis and attention must be paid to prevention and arranging oral rehydration facilities to resuscitate and treat children. Outbreaks of infections such as cholera [21], rotavirus [22,23], tetanus [24,25], malaria [26–28], typhoid [29], shigellosis, novovirus, leptospirosis, and others have all been documented following natural disasters [20].

Other pathogens that have been involved in outbreaks of disease include viruses including dengue [27], and malaria [26–28]. Rabies may be a problem in some parts of the world.

It is important to note that when people are grouped together into a high population density, a much higher level of immunization is required to prevent the development of epidemics [30]. Following the 2007 tsunami, spread of measles was documented in a population that had had 1 dose of vaccine following the tsunami [31].

Clearly early involvement of public health experts in the management of disaster aftermath is vitally important. A manual has been produced by the WHO to provide guidance for health care workers who may be called on to provide care for children in humanitarian disasters.

One of the issues that is often seen as a priority following disasters is the disposal of dead bodies. In fact these are not a major infection hazard, and it is likely that it would be better to try and allow families every opportunity to mourn and bury their dead, rather than to use mass graves [20].

Urgent and rapid epidemiological assessments by teams with pediatric expertise may be useful in disease prevention and treatment following disasters.

There is limited data available on the effect of respiratory viral pandemics on children [32]. However, experience from the SARS outbreak in Toronto in 2004 highlighted the need for extensive planning for infection control measures before the outbreak of an epidemic and management of epidemics involving children using a family-based approach [33]. Children are particularly vulnerable to adverse effects of isolation, and this may be a significant problem in management of other outbreaks [33]. In the case of SARS there seemed to be limited spread of the infection from

children to adults [34] but that may not be so in other pandemics. Schools and institutions for children may be also an important source of cross-infection in communities exposed to pandemic infections.

Environmental Dangers Exposure Following Disaster

Following disasters there may be an increased exposure to many toxins. Carbon monoxide poisoning has occurred on many occasions because of the means used to provide power and warmth [35].

Following Hurricane Katrina in the USA >200,000 people were rendered homeless and many were given temporary accommodation in mobile homes. Many of those homes were found to be contaminated with formaldehyde, and the management of related symptoms was complicated by the fact that the healthcare structure surrounding those in displaced housing was inadequate [36].

In many settings the post-disaster environment may have many dangers such as unstable masonry, exposed power and gas lines, contaminated soils and environments, etc. Children with their capacity for exploration and limited knowledge of potential dangers may be at substantial risk, particularly if adult supervision is compromised (as will usually be the case post disaster).

Effect of Conflicts

There is relatively little data available that compares the rates of mortality following conflicts with baseline data. Guha-Sapir and Gijsbert reviewed data from 37 available datasets, and showed that there were considerable differences in mortality rates for children following conflicts [37]. In most cases the rates or death increased sharply, although there were other situations in which mortality rates dropped, largely related to populations who were displaced as a result of the conflicts.

Complex Disasters

In mass displacements (usually as a consequence of war or civil strife) children under 5 have often had the highest mortality. In these situations "Complex emergencies" defined as "relatively acute situations affecting large civilian populations, usually involving a combination of war or civil strife, food shortages and population displacement, resulting in significant excess mortality" [38] may occur. Essentially these disasters combine many of the individual components of issues described above.

During the 1980s the mortality of children aged 1–14 in areas such as northern Ethiopia (in 1985) and Southern Sudan (1988) were extremely high [38]. In the 1990s crude death rates in refugees in some parts of Africa were 5–25 times higher than the crude death rates of the nondisplaced (with rates of up to 80 times described

[39], and the rates were highest in children under 5 years of age [40]) leading Toole et al. to state that "Children under the age of 5 regularly bear the brunt of the death toll associated with complex emergencies" [41]. Likewise in 1996, 54% of all the deaths among refugees from Rwanda and Burundi who fled to eastern Zaire were under the age of 5 [42]. A recent publication [43,44] has reviewed much of the data. One of the problems quoted is that much data is in "gray data" which is not readily available to the greater audience.

Children are also affected by the patterns of adult mortality. In many settings such as the Indonesia tsunami three women died for each man [45], and as most child care is provided by women, their children would have been adversely affected.

Fortunately much has been learned about the management of complex disasters [46], and there is hope that future events will provide better care for children. The issues of relief work in complex disasters are extremely complex and challenging to all concerned.

Psychological Concerns

There is a large body of evidence documenting the psychological problems of children who have been exposed to disaster situations [47–49] which has been recently reviewed [50–53].

Specific and focused care is required from the time of the disaster onwards to ameliorate the long-term psychological problems for children affected by disasters [54]. Particular attention needs to be focused on the family [55].

Penrose et al. have recently highlighted the importance of involving children in the process of planning for disaster, as well in the recovery phases following events. Children can offer useful knowledge and information, and it is deeply in their interests to feel part of the processes that surround actual and potential disasters. "The children consulted have clear ideas about the information, knowledge, and skills that they and their communities need to be better prepared for future disasters; all we have to do is listen." [56]. The same authors have raised many issues surrounding children's rights in disasters and ways in which they can be addressed [56].

It is also important to bear in mind that dealing with child victims of disasters or mass casualty events can be extremely demanding and emotionally devastating for healthcare and rescue workers [57,58]. Specific steps must be taken to provide support to these people both during and after the events.

Resources for Care of Children in Disasters

In any disaster, there may be direct (e.g., injury related to the earthquake), or indirect consequences (e.g., subsequent epidemics) which may be physical or psychosocial in nature [30] (or both).

Not only are children more likely to suffer injury in physical disasters, the facil-

ities available for their care are likely to be more limited than would be the case for adults. The special needs of injured children include: a range of equipment sizes; personnel with special expertise in dealing with children; increased nursing requirements post intervention, etc.

Particular insight into the needs of children and the availability of specific pediatric resources will be required by any team coordinating both planning for and response to any disaster in which significant numbers of children are involved [1,14,59,60].

Facilities

Even within well-resourced areas children's services in general have extremely limited capacity to deal with a surge and there are limited alternatives [61]. Recent reviews considered options for surge management for adult patients, but did not include children [62–64]. Although up to 45% of the population in developing countries may be pediatric, there are usually far fewer pediatric services than there are adult services.

In the USA about 37% of hospitals have both emergency departments and separate hospital wards with specific facilities for children, while 10% do not admit children [65,66]. Only 5.5% had all the equipment recommended for emergency care for children, while about 50% had 85% of the equipment suggested in the 2001 guidelines [67]. Thus capacity to accommodate a large surge of pediatric patients may be limited, even in countries as well-resourced as the USA.

Kanter and Moran [68] have reviewed the adequacy of pediatric beds in New York City for mass casualty purposes. The current bed numbers could accommodate approximately 250 children per 1 million population assuming no surge in current demand and that all beds were available. Even if there were reductions in the intensity of care to allow 20% more admissions, it would not be possible to accommodate more than 300 children per million population and more than 63 children per million in PICU even if the standards of care were altered to allow quadruple the usual throughput. Disaster situations involving 500 children per million and with 30% requiring intensive care would almost always exceed PICU capacity. To further compound the situation 55% of all PICU capacity was located in four hospitals. The WHO has recently launched a campaign aimed at ensuring that health facilities remain safe during and after disasters "Health facilities are only truly safe from disasters when they are accessible and functioning, at maximum capacity, immediately after a hazard strikes." (http://www.who.int/hac/techguidance/safehospitals/en/index.html) (Safe hospitals document) and this is of particular relevance to pediatric facilities.

There is frequently a "surge" in demand for injury care shortly after the onset of the disaster. At a teaching hospital in Sri Lanka for instance there was a 50% increase in admissions on the day of the 2005 tsunami (with 89% injuries). The rate of admissions for injury remained high for the next week [69]. However, the ongoing need for additional care may be high, particularly in the setting of burns (or other injuries

requiring multiple surgical procedures or investigations) or children requiring intensive care. Thus the surge may be sustained, and is always superimposed on existing service requirements.

Fortunately, there are few reports of disasters overwhelming the capacity of children's hospitals. However during the Hurricane Katrina disaster in New Orleans, it was necessary to move significant numbers of critically ill children and neonates away from affected areas to other hospitals. Patients requiring transportation included those affected directly by the hurricane, but also those who were in neonatal and pediatric wards and critical care areas at the time of the event [70]. This may be much more challenging or even impossible in other contexts.

It may be necessary to provide accommodation for parents and caretakers at the health facility where the children are being cared for. This may be particularly important when the surrounding environment is significantly affected by the disaster [71].

Following the early phase of a disaster shortage of healthcare facilities for children (if facilities have been damaged during the acute incident) may remain a significant problem for a long period unless there is focused rehabilitation of pediatric services. Even provision of accommodation and health care for relatively well (but displaced) children may be a problem [59].

Equipment

The equipment required for the care of children (and particularly small children and infants) is different from that required for adults. In a study of preparedness of pediatric disaster assistance teams, Mace and Bern reviewed the availability of pediatric resources. Pediatric equipment was missing as follows: airway, 16%; intravenous lines, 37%; cervical collars, 38%; medicines, 38%; Broselow tape, 46%; backboards, 62%. Pediatric patients were included in disaster drills 63% of the time [72]. A review of emergency departments in the USA again showed significant deficiencies in availability of pediatric equipment [65].

Recommendations to ensure the availability of pediatric equipment include appropriate stocking of pediatric emergency departments [67], some stockpiling in pediatric practice offices [1], or the collection of pediatric equipment in international relief equipment collections.

The majority of injuries requiring early treatment will be orthopedic and hence there is a major need for orthopedic devices which may be short supply, particularly in the countries affected [73]. This was also expressed by Laverick et al. with regard to their experience following the Pakistani earthquake [12]. Experience has shown that there may be many spinal cord injuries [74,75] after earthquakes.

Provision of Food and Pharmaceutical Supplies

Children have different food and pharmaceutical requirements than adults. For small infants, breast feeding remains the most important source of nutrition and should be

encouraged if at all possible. A study from Pondicherry following the 2005 tsunami showed that breastfed infants who were given formula feeds had a threefold higher incidence of diarrhea [76].

Noji et al. [77] have commented on the challenges of providing appropriate medication, immunization resources, and nutritional support for children following disasters. Extensive recommendations relating to these problems are available from the WHO [2].

Personnel and Organizational Structures

Pediatric expertise is required at many stages of the management of a disaster involving significant numbers of children [60,78]. This ranges from triage systems at the point of first contact with the injured children, through emergency and intensive care services, to ongoing medical and rehabilitative care. Expertise is also required at different levels in the organization of relief efforts from management of the casualties, management of evacuation and transportation, allocation of resources, and management of overall relief organization.

Personnel

The number of people within rescue and health care services who are trained and experienced in the care of children may be extremely limited. Mace and Bern [72] reviewed the capacity of disaster medical assistance teams in the USA to respond to pediatric emergencies and found major deficiencies in the training curriculum with pediatric topics such as trauma, disaster triage, burns, pain management, and mental health missing in 33, 36, 42, 42, and 45% of the time, respectively.

Data from emergency units in Israel showed that the staff were significantly less well prepared to cope with pediatric mass casualties than with adults [6].

There is a need to involve pediatric trained personnel in the disaster management process [14] at all levels. However, those personnel are unlikely to be of significant assistance unless they have gone through some training [79] as the skills required in an acute disaster are very different to normal pediatric practice.

Processes

Management of large groups of patients requires multiple levels and command structures.

At the point of first patient contact, and subsequently in the hospital services, there is a need for triage systems. Triage systems used for adults may overestimate the severity of injury of children [60], and not be a problem when small numbers of children are involved. However, when large numbers of children are affected it is important that pediatric triage systems be used. A number of systems have been

devised including the Pediatric Triage Tape, Simple Triage and Rapid Treatment (START), JumpSTART, and Careflight systems. JumpSTART was the only system available to 32% of disaster medical assistance teams in the USA [72]. However, when application of the systems was assessed in a South African emergency department the Careflight system had the highest specificity and sensitivity with similar performance from the Pediatric Triage Tape. The JumpSTART and START systems did not function well [80].

Weiner et al. [14], within the context of disaster relief for Hurricane Katrina, have clearly described the role that pediatric subspecialty teams within the national disaster management system can play. The teams that were deployed had been trained specifically prior to that event, and had prepared for the possibility of a hurricane affecting New Orleans.

Pediatric Planning for Disasters

A recent survey of emergency medical systems in the USA showed that although 72.9% of agencies had mass casualty plans in place, only 13.3% reported having specific pediatric mass casualty plans [81].

Planning for the needs of children is complicated by a number of factors. Children are not a homogeneous group of people. Children of different ages and developmental stages have very different needs (infant foods vs. adult nutrition), capacity to respond to situations (adolescents vs. infants), vulnerability to infection (infants vs. adolescents), needs for parental care, etc. There are also children with specific needs, and in the richer parts of the world there is an ever-growing population of children who are dependant on technology such as home ventilators.

Some disasters are completely unexpected, and detailed planning to deal with such events is impossible. However, many disasters are predictable and with increasing access to geological, meteorological, and other data across the world, many regions will have increased capacity to consider and plan for disasters. While it may be impossible to make adequate plans for events such as the Kashmir earthquake in 2005 in which some 86,000 people were killed and 80,000 injured [82,83], there are many other disasters for which appropriate planning can and should be made. In many cases children are included under the category of "vulnerable people," and specific plans are not made to deal with the needs of children. Improving pediatric emergency care needs should be at the forefront of every disaster planner's agenda [19].

Appropriate disaster planning should include: measures to reduce the injury during possible disasters, organization of emergency and pre-hospital services to deal with emergencies, plans for utilization of health services and utilities such as hospitals and intensive care units, and contingency plans to provide accommodation and resources to support both the rescue efforts and the ongoing needs of displaced people

In the 2008 Sichuan earthquake, which is reported to have killed some 90,000 people, the Chinese government has reported that 5,335 children died when school buildings collapsed on them (http://www.timesonline.co.uk/tol/news/world/asia/article6239476.ece accessed 2nd June 2009). Appropriate building standards for institu-

tions in areas at risk for seismic events could reduce death toll, even though it could be argued that the devastation was related to the force of that particular earthquake.

In 2007 Rassin et al. [6] found that in Israel, despite well-developed plans for mass casualty events, there were "no epidemiologic data concerning children affected by MCEs in Israel and no unique recommendations to enable the Ministry of Health to prepare for coping with such pediatric casualties." Shirm et al. [81] have completed a recent survey of emergency departments across the USA showing that about 50% have not met with schools or child care agencies to discuss the care of children in the event of a mass casualty.

The role of adults who are in charge of children such as teachers, nurses, and caregivers should be defined. Particular responsibilities of organizations that care for large groups of children whose needs will differ depending on the age group and the particular characteristics of the children at that institution – e.g., special schools and hospitals – should beaddressed. In addition, plans should be developed to deal with children whose caregivers are missing. A crucial part of pediatric planning for disasters is comprehensive involvement of the communities that may be affected [84].

Disaster planning can take place at many different levels within the community, both national and international. To some extent the level of planning is also affected by the relative size of the likely disaster.

Planning of disaster management processes and structures should incorporate schools and educational facilities. Incorporation of pediatric health services in planning may include the utilization of both public and private resources and the designation of some adult hospitals as alternative centers for pediatric care.

Planning is constrained by the resources available, and if health care resources are already inadequate or are functioning at the limits of capacity, then it may not be possible to plan for large disasters in any meaningful way. It is in this scenario that the international community may have a role in developing resources with which to assist in the amelioration of disasters across the world.

With regard to organization of responses to emergencies, a common theme is that there needs to be centralized control centers that monitor and keep processes in action. A deep concern is that the people and systems that are put in this position are fully competent to deal with children's issues. These concerns arise from the recognition of the following:

1. It is often relatively easy to get resources (often the wrong ones) in the short term, but much more difficult over a longer period of time.
2. The need to get the correct resources, and not what the people in other countries want to give.
3. The need to work out how to deal with "excess resources" and make sure that these are not actually sources of development of ongoing crime and corruption.

Training Courses

Olness et al. [85] have described their experience of establishing and running training courses for health professionals in management of children's needs in disasters

and emergencies. The training course is based on the extensive experience of faculty who have worked in emergencies across the world on many occasions. Some of the topics to be covered in the course include: definition and overview of disasters; the international humanitarian disaster response system; rapid epidemiological assessment; triage; malnutrition; renal emergencies for children in disasters; water, shelter, and sanitation; logistics and resource management; personal preparedness; infectious diseases and immunization; and the psychosocial issues for children who suffer disasters.

However there is considerable evidence of major deficiencies in the training programs for staff who may be required to care for pediatric mass casualties [72].

The AAP (all the websites related to disasters) the WHO (website-based materials), and other organizations have put significant emphasis on involvement of families in preparation for disasters [1].

Ethics Related to Children in Disasters

A number of authors have considered the principles of resource allocation in the context of mass disasters [86–88]. One of the underlying problems from a critical care perspective is that many intensive care systems are currently operating at 98% of capacity [88]. There is also data suggesting that the capacity to upscale intensive care facilities for adults (even with a gradual onset disaster) would be maximum at 30%. It is likely that the potential to increase pediatric intensive care beds to cope with mass casualties may be substantially less that that.

Essentially it is likely that in most countries of the world there would be limited capacity within the health systems to deal with a significant surge in demand for acute services for children. In most developing countries there is simply no capacity at present to deal with the current demand, and in both situations we will have to work out how to provide the best possible care to the affected children.

While some general principles appear to be recognized for the triage of adult patients [86,88–97], there is very little published material on the allocation of scarce resources for children in the context of mass casualties or disasters [80,98]. The tenets of the accountability for reasonableness [99–102] may be useful in working through this process.

As it is simply not tenable for clinicians involved in disaster care to make these decisions on their own, there is an urgent need for communities across the world to consider and discuss the possible approaches to allocation of scarce clinical resources in disasters in their region. This may be relatively straightforward within countries, but becomes extremely problematic in the context of disasters in countries where foreign healthcare workers are brought in as part of the response to the emergency.

Dealing with the Long-term Consequences

The long-term consequences of disasters may affect every level of society; however, there is a specific need to address the health care needs of people who have either been displaced or severely affected by the disaster. In many cases healthcare services will be curtailed in the disaster and these need to be rebuilt and redeveloped in a configuration that is appropriate to the new context. In addition, development of those services must take into the account the health consequences of the disaster which may operate over a range of time scales. Particular attention may need to be paid to the ongoing development of mental health services.

In the Bhopal gas tragedy in 1985, it was estimated that the death toll 1 week after the event was approximately 2,500, by the end of 1989 the mortality was estimated to be 3,598, and by the end of 1994 the numbers were approximately 6,000. By 2001 it was estimated that disaster-related deaths may have been between 15,000 and 20,000 [11]. Thus the systems required for health effects may need long-term commitment.

Conclusions

In summary, planning must address the unique needs of children (immediate and long-term) the context of the likely disaster, and the resources available. Planning should involve clinicians, health planners, the public, and children. Protocols and processes should be devised a priori and should be transparent, taking into consideration the ethical principles of fairness and equitable care.

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Suggested resources

CDC http://www.bt.cdc.gov/disasters/

Children and disasters. Website related to the American Academy of Pediatrics. http://www.aap.org/disasters/index.cfm (accessed 2nd June 2009)

Federal emergency management agency website for children. http://www.fema.gov/kids/ (accessed 2nd June 2009)

http://www.health.state.ny.us/facilities/hospital/emergency_preparedness/guideline_for_hospitals/section_14/psychosocial.htm (accessed 2nd June 2009)

Safe Hospitals Bibliography http://safehospitals.info/index.php?option=com_newsfeeds&task=view&feedid=11&Itemid=198 (accessed 3rd June 2009)

The Youngest victims: disaster preparedness to meet children's needs. http://www.aap.org/disasters/pdf/Youngest-Victims-Final.pdf (accessed 2nd June 2009)

WHO Health Action in Crises http://www.who.int/hac/en/ (accessed 3rd June 2009)