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Provisional chapter

Meeting the Medical and Mental Health Needs of Children After a Major Hurricane

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1. Introduction

The large number of hurricanes in the Gulf Coast region of the United States after the year 2000 has been a great stimulus for research in health effects and health care delivery after a major hurricane. Much of this study has been devoted to children, with over 200 publications on the subject, nearly three quarters of which were published after Hurricane Katrina in New Orleans, LA (2005). Importantly, this recent research has focused not only on meeting medical health care needs of children, but also on meeting mental health needs which might be unique to the aftermath of a major disaster. This chapter will provide a comprehensive review of this literature, providing a resource for health care providers who are coordinating and providing care after a major hurricane.

The major categories for review are of course medical health and mental health. Within medical health, issues of mortality, acute injuries, ongoing care of existing medical conditions, epidemics, toxic exposures, and effects on long-term health care will be discussed. Regarding mental health, acute and chronic post-traumatic stress disorder and serious emotional disturbance will be reviewed, as well as the impact on other children who might not meet full criteria for these disorders. Impact on children with ongoing mental health needs will also be reviewed. Importantly, success rates and overall impact of therapeutic interventions will be discussed, as these are critical for future hurricane events.

2. Medical health

Issues of medical health needs after a major hurricane can be divided in those in the immediate post-disaster response and ongoing needs which may continue for several years. While

acute health care needs and delivery systems in the form of disaster response teams have received considerable attention, those related to more chronic needs are only beginning to be recognized as issues, as needs have arisen after the most recent events. Individuals with chronic medical conditions face special challenges, both acutely and long-term. Toxic exposures related to hurricanes are considered separately. Preparedness is considered last, as improvements in tracking of health care needs which follow a disaster have been leading to revisions in the planning process at all levels.

2.1. Mortality

Mortality statistics are among the first health-related complications of hurricanes to be reported. The United States Centers for Disease Control has been tracking and reporting hurricane-related deaths since hurricane Andrew [1]. In fact, early reports regarding health-related outcomes of hurricanes consist almost entirely of mortality statistics [2-5]. Likewise, efforts for health-related disaster planning were directed towards minimizing storm mortality, by early warning and effective evacuation procedures [6]. Reports on hurricane Isabel started to break down hurricane-related deaths by cause, separating those from the storm itself ("Direct"), from those which occurred during the evacuation procedures and in the aftermath of the storm ("indirect") [7]. Importantly, this analysis also revealed that alcohol or drugs was a factor in 28% of storm-related deaths, and that public education efforts should focus on avoiding these during storm events. Unfortunately, there was very little evidence that residents of New Orleans were attentive to these recommendations following Hurricane Katrina – "hurricane parties" remained ubiquitous, and beer was more likely to be taken from convenience stores than water. A summary of hurricane-related deaths in 2004-2005 revealed that 59% of deaths occurred in the postimpact phase, mainly from injury, electrocution, and carbon monoxide poisoning [8]. After hurricane Ike in Texas, carbon monoxide deaths (13) exceeded those from drowning (8) [9]. That said, severe storms can still cause significant injury and mortality, particularly if people are not in reinforced structures [10]. While Hurricane Katrina caused significantly greater overall mortality than these storms, the mortality rates in children were largely unchanged in the pre- and post-storm periods [11]. Of note, the same study notes that infant mortality actually declined, but that this likely was the result of evacuation of high-risk premature infants before and after the storm.

2.2. Injuries

Minor injury is a known risk related to hurricane events, as high winds causes damage to structures, increasing risks for injury of the occupants. As such, injury would be expected to be the overwhelming most common reason for individuals visiting an emergency room or an medical relieve site after a major hurricane. This is recognized in the earliest reports [12], with the reported increased injuries presumed to be sustained during the storm itself. However, a more comprehensive review of hurricane-related health care visits after Hurricane Andrew indicated that the majority of injuries treated occurred after the storm had passed, during the clean-up activities [13]. Even more importantly, the combined number of visits

for injuries were only a only a small fraction of those seen for ongoing care of existing medical conditions, as is discussed in the next section.

Disaster medical teams see a particularly high proportion of acute minor injuries in the overall population, as would be expected [14]. Chain saw injuries, presumably related to the clean-up efforts, are common in adults [15]. Interestingly, this same report highlighted a disproportionately large number of insect stings in North Carolina following hurricane Hugo. This has not been reported in series from other hurricane events, and in fact a dermatitis epidemic from moth exposure following hurricane Gilbert was attributed to reduced number of stinging insects (the moth's main predator) from the storm event [16]. In addition to injuries, there were increases seen in other common reasons for visiting the ED for adults, such as cardoivascular disease and asthma [17]. In children, the emergency departments reported increased cases of open wounds, gastroenteritis, and skin infections after Hurricane Andrew [18]. While most of the injuries are minor, a significant proportion are major enough to require hospitalization or surgery [19]. On the other hand, there was no report of increased injuries in children in Jamaica following hurricane Gilbert [20]. Accelerant burn injuries are also seen in greater numbers, likely due to use of gasoline-powered electric generators [21]. Traumatic injuries (falls and cuts) were reported in both residents and relief workers after Hurricane Katrina, although the greater number occurred in residents, presumably because of their much greater numbers [22]. The continued presence of floodwaters after Hurricane Katrina lead to more complications of infections with laceration injuries [23]. Interestingly, in contrast to other flooding events in New Orleans, increased numbers parasitic infections were not reported, presumably because the floodwaters were the result of a salt water rather than fresh water incursion.

Injuries are indeed a prominent feature of hurricane-related health issues which prompt the need to seek medical attention. However, the majority of these injuries are sustained not during the storm itself, but rather during the efforts to clean up and repair damage after the storm. Reports of increased injuries in children are inconsistent, presumably because the children are less likely to be participating in the riskiest clean-up activities.

2.3. Ongoing care for existing medical conditions

A major disaster can cause major disruptions to the health care infrastructure, such that any ongoing health care needs can become difficult to meet. As a result, the majority of health care provided in the acute setting is related to management of ongoing or acute minor illnesses that would normally be cared for by the primary care provider. This has been reported consistently in analyses of several different major hurricane events [13, 24, 25]. Hurricane events with more extensive and widespread damage see a greater proportion of these ongoing healthcare and medication refill visits, reaching as high as 90 percent after Hurricane Andrew and Hurricane Katrina [13, 26]. Interestingly, a similar experience was reported in Korea after Cyclone Nargis [27]. Mobile medical units were established to help meet this need [28].

The types of visits observed for ongoing care were mostly adults who are taking chronic medications for minor ailments (i.e. hypertension) [13, 26]. Other illnesses reported by those seeking care include cardiovascular disease, chronic respiratory disease, ob/gyn conditions,

and diabetes [29]. Children are less likely to be on chronic medications for such conditions, and those who are on chronic medications are generally receiving them for less severe conditions, i.e. seasonal allergies. However, those children who do suffer from chronic medical conditions have unique health care challenges in a disaster, as is discussed below.

Following Hurricane Katrina, children with chronic medical problems were found to be at increased risk for adverse events, including worsening of asthma, running out of medications, and experience disruptions in care [30]. Disruptions in care and decreased patient adherence rates were reported in TB clinics as well, for both children and adults [31]. Patients with sickle cell disease who relied on the public hospital system for their care reported greater long-term problems with access to care than did those receiving care primarily through private hospitals [32]. A year after Hurricane Katrina, the overall incidence of chronic medical problems was reported to be increased in children living on the Gulf Coast [33]. This is a surprising finding, given that one might expect families of children with chronic medical conditions to be more likely to relocate to an area where specialized healthcare is more accessible following a major hurricane event. It suggests that children with latent conditions may be more likely to come to clinical attention following a storm event, perhaps as a result of toxic exposures in the post-storm period.

Prior to hurricane Ike, the majority of families with type 1 diabetes mellitus were prepared for at least short-term (3 day) medical needs, although those with lower socioeconomic status were less well prepared [34]. In fact, the families were found to be better prepared for emergency diabetes management than they were for disasters in general. Likewise, metabolic control did not differ significantly overall for patients with type 1 diabetes after Katrina [35]. However, it is worth mentioning from personal experience that my only case of diabetic ketoacidosis complicated by cerebral edema occurred one month after Hurricane Katrina, the severity of presentation was most likely exacerbated by the ongoing disruptions in health care and emergency services. One should also mention that one of the major challenges for children with chronic medical conditions following Hurricane Katrina resulted from the extended evacuation period, such that 3 days worth of medical supplies were quickly exhausted. Special shelters were provided with those with medical needs and their families to help address acute needs of these patients [36], including replenishment of short-term supplies and medications as the evacuation period was extended.

Regarding long-term delivery of healthcare for children with other conditions, rates of patients with cochlear implants actually increased for a major program after Hurricane Katrina [37], while care of patients with craniofacial abnormalities was temporarily disrupted [38]. Some of these improved long-term outcomes may be related to establishment of a system of "medical homes" to coordinate care for children with chronic illnesses [39].

While not necessarily a chronic illness, it is worth noting that newly-diagnosed cancer patients who were currently undergoing treatment were displaced by Hurricane Katrina, according to review of cancer registry data [40]. This represents a special concern, as access to records regarding ongoing chemotherapy regimens can be critical for therapies to be successful and to limit toxicity. Likewise, both Tulane and Louisiana State University had trans-

plant programs for children, and ongoing surveillance and immunosuppressive therapy would be complicated by the transfer of care and inability to access previous records.

Overall, ongoing care for chronic medical conditions becomes a major challenge when the local healthcare system is disrupted by a storm event. Hurricane planners should focus on meeting these needs, ensuring a ready supply of the most commonly used drugs and supplies in treating these conditions, and adequate urgent-care type medical facilities to meet the needs of these individuals.

2.4. Evacuees

While much study has been devoted to administration of care to victims at the site of the disaster, the ability to evacuate large populations en-masse to more distant centers extends the need to provide health care services at these locations as well. Of course, the minor injuries resulting from clean-up activities would not be expected in those who have been evacuated to distant centers. However, issues of displacement represent challenges of their own, as evacuees would have no access to their primary care physicians and limited access to pharmacies. After Hurricane Katrina, people were evacuated to almost 1,400 centers in 27 states [41, 42]. Basic needs reported in shelters included dental care, eyeglasses, acute illness, and ongoing management of chronic illnesses [41-43]. Only a small percentage (3.8%) required hospital referral [42]. Monitoring systems were established in some shelters after Hurricane Katrina to provide health needs for the evacuees and to prevent outbreaks [44]. As evacuees are dispersed from designated centers, impacts can be felt on the local health care system akin to a wave of immigration [45]. Of course, that evacuees are presumably relocated to a region with an intact health care system provides a huge advantage in meeting these individuals' healthcare needs.

2.5. Epidemics

Hurricanes cause damage to infrastructure and can force people into closer living situations (i.e. shelters), increasing the chances of outbreaks of infectious diseases. Highly contagious disorders can become epidemic after hurricanes, as was seen in St. Croix after Hurricane Georges, where 88 cases of conjunctivitis were reported in one public health clinic a week after the hurricane (the previous case rate was 3 per month) [46]. Evacuees from Hurricane Katrina in the Astrodome developed an outbreak of gastroenteritis from Norovirus [47]. Fortunately, improvements in surveillance at that site helped prevent this outbreak from becoming more serious [44].

Waterborn infections or infections with water-dependent vectors can also occur more frequently, particularly when prolonged flooding occurs. Dengue fever outbreaks have been reported in Puerto Rico associated with hurricanes and floods [48]. Haiti also experienced difficulties with mosquito-born diseases (malaria, dengue fever, and West Nile Virus) after Hurricane Jeanne [49]. Importantly, these were the first cases of West Nile Virus reported in Haiti, underscoring the need to consider the possibility of disease outbreaks which are otherwise atypical for the region after a hurricane event. An outbreak of waterborn cholera was

seen in India after Cyclone Aila [50]. As an interesting variation on hurricane-related epidemics, dermatitis as a result of contact with the *Hylesia alinda* Druce moth was reported in high numbers in Cozumel, Mexico following hurricane Gilbert [16]. A full survey revealed that 12.1% of the population was affected. The link with the hurricane was death of the moth's natural predators, bees and wasps, which allowed the moth population to overgrow.

Outbreaks of infectious disease are a long-recognized risk following hurricane events, and as such, it is thus not surprising to see that surveillance systems and effective responses are being employed during hurricane relief efforts.

2.6. Toxic exposures

Exposure to toxins following hurricanes can come from many sources. Mould and spores growing in flooded houses can cause respiratory difficulties. Toxins such has heavy metals can be released from damaged buildings. Gas generators running continuously can generate excess carbon monoxide if not adequately ventilated. These unique exposures to toxins need to be considered in planning and response to hurricane events.

2.6.1. Respiratory

Asthma is very common in children, and exacerbation of asthma symptoms by hurricanes and the associated flooding is of great concern. As noted previously, childhood visits to emergency rooms for asthma are increased after Hurricane Katrina [29]. A similar experience was reported in North Carolina after flooding from Hurricane Floyd, which damaged schools [51]. Importantly, increased respiratory complaints were not limited to individuals with a pre-existing diagnosis of asthma, as a survey of the general population revealed increased complaints of both upper and lower respiratory symptoms [52]. A general increase in minor respiratory complaints in children was noted in Jamaica after hurricane Gilbert [20]. Risk factors for respiratory disease identified in the study include roof or window damage, outside mould, dust, and interior flood damage. It is thus not surprising that respiratory complaints are among the most consistently reported in surveys of emergency rooms and shelters, as indicated previously, and responders should be prepared to treat a large number of children presenting with these disorders.

2.6.2. Mould

Contamination of home interiors with mould was of great concern after Hurricane Katrina. Many houses were flooded for a month or more, and interior walls of such homes would typically be entirely coated with mould growth. There was concern if all of the mould could be removed from such homes. While this has generated much discussion in the lay press, only one study actually reported mould as a risk factor for respiratory complaints, and this was linked to outdoor mould [52]. A preliminary study in New Orleans showed surprisingly low respiratory symptoms (based on spirometry) and surprisingly low exposure to mould (based on air sampling), both of which improved quickly over a 2 month period [53]. However, this study was conducted in the Garden District, where there was minimal flooding. Concerns about

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mould exposure are not limited to hurricanes, of course, and experiences with excess in-home mould exposure after hurricanes have stimulated policy development to provide better control of mould and moisture in all homes [54].

2.6.3. Lead

New Orleans is an old city, and as such there were difficulties with lead contamination and exposure to children prior to Katrina [55]. There was concern that the combined effects of storm damage and subsequent renovation would increase risk of leat exposure further by releasing even more lead into the local environment [56]. Mild increases in soil lead levels after Hurricane Katrina were seen in properties previously treated with fresh soil for heavy lead contamination – the soil did not wash away, but rather was re-contaminated from lead released from damaged buildings or during the renovation process [57]. A broader risk analysis for soil lead levels after Hurricane Katrina yielded similar results [58]. Another random survey showed a high proportion (27%) of New Orleans homes with lead levels in surrounding soil well above recommended levels, and average lead levels were increased from those obtained before Hurricane Katrina [59]. Schoolyards were not spared, raising particular concerns for returning children [60]. Importantly, soil lead levels have been correlated with blood lead levels in New Orleans both before and after the storm [61], indicating that release of lead into the environment can have adverse consequences for children. Increased lead in the soil around heavily damaged homes needs to be considered after a hurricane event, and attention needs to be paid during the rebuilding process that renovations do not worsen the situation.

2.6.4. Carbon monoxide poisoning

Massive, prolonged power failures following a hurricane event will result in increased use of gas-powered electric generators. To avoid theft, these generators are often placed to nearer to homes or within covered porches. A Florida study noted some gas-powered generators were placed in garages, or even inside the homes themselves [62]. Carbon monoxide exhausts can become trapped in the home and create a slow, chronic exposure for the occupants. A CDC investigation in Alabama and Texas found 27 incidents in hurricane-affected areas, resulting in 10 deaths [63, 64]. While the majority of individuals were found to be using generators to power stoves or window-unit air conditioners, one study cited deaths following hurricane Ike related to generator use solely to power television and video games [65]. Of note, carbon monoxide poisoning from other causes, particularly automobile exhaust, occurs year-round, accounting for nearly double the number of cases in Florida from those related to gasoline-powered generators [66]. In response to this important source of post-storm morbidity and mortality, public health measures have been taken to educate people about the risks of use of gasoline-powered generators, and how to take steps to minimize those risks.

2.7. Hospitals

In addition to facing all of these special health issues among the served population, hospitals face challenges of their own in a hurricane setting. Decisions about whether to evacuate patients prior to the storm's arrival, and which patients to evacuate, can be problematic [67]. Pow-

er outages can strain back-up generator systems, and evacuations and damage to residences can adversely affect hospital staffing. Major flood events, causing failures of power (primary and backup), running water, and, most importantly, sewerage, forced hospitals in downtown New Orleans to close after Hurricane Katrina. Evacuating remaining patients from these hospitals was especially problematic under the circumstances. A seemingly minor point, but one which is potentially critical for nation-wide public health, is the transfer of bacterial flora between hospitals; patient evacuations raised concerns of spread of multidrug-resistant bacterial strains across the country [68]. Despite these logistical challenges, orderly evacuation of pediatric patients was conducted to other hospitals in the southeast [69, 70]. However, evacuations were not immediate, and the challenges, particularly in ICU settings, of providing continued care in the absence of basic resources, required considerable resourcefulness on the part of hospital staff [71]. Fortunately, hospital staff are trained to work under extreme circumstances, and likely by nature of career choice show remarkable willingness to work in disaster setting. In polls of hospital staff conducted across several states, 78% of respondents indicated they would be willing to work through a hurricane [72]. Overall (personal bias notwithstanding!), hospitals can generally be relied on to perform extremely well during hurricane events, with stockpiles of supplies, emergency power systems, serving as anchor points for health care delivery and for other elements of the hurricane response team.

2.8. Long-term effects on health care delivery

The effects of hurricanes and relief efforts which follow on the local health care infrastructure are quite variable. In response to hurricane Mitch, the American Red Cross undertook a program to improve water and sewerage infrastructure in Central America, resulting in decreased prevalence of diarrheal illnesses from pre-storm rates [73]. Long-term access to health care was also significantly improved in the region as a result of the relief efforts [74]. While federal efforts to promote recovery of the health care system after Hurricane Katrina provided funding and resources to hospitals and community health centers, no assistance was offered to private practice physicians [75]; in fact, temporary funding for mobile health clinics had the opposite effect of creating free competition, further straining the private practice model and leading to long-term shortages in primary care physicians in the region, particularly in the field of obstetrics/gynecology.

Access to vaccination records is of great importance, particularly for hurricane evacuees, as proof of vaccination is generally required for children to be allowed to enter school. In the United States, vaccination records are maintained by the individual states rather than in a common federal repository. Connecting the Louisiana and Houston-Harris County immunization registries allowed recovery and immediate access to childhood immunization records after Hurricane Katrina [76]. This allowed for considerable cost savings, preventing the need for re-vaccination of children because of lost records [77].

2.9. Growth and development

Access to adequate food and water can be limited following a hurricane, and there are concerns regarding growth and development of children under these circumstances. Likewise, the

stress of the situation can have direct effects on growth and development as well. Growth in height was significantly reduced in Jamaican children following hurricane Gilbert [20]. Higher levels of malnutrition were reported in several regions of Honduras after hurricane Mitch [78]. Decreased incidence of precocious puberty and increased incidence of pubertal delay was observed in New Orleans after Hurricane Katrina [79]. In all cases, adequate available nutrition was well-documented in the study populations, so it appears likely that other storm-related issues affected the distribution of food in relief efforts, or that other medical factors (i.e. stress) influenced growth and development in children in the post-storm period.

2.10. Maternal-fetal health

Exposure of mothers in the second and third trimester to hurricane conditions resulted in increases in several measures of fetal distress [80]. A significant increase in autism was noted in children with prenatal exposure to hurricanes, particularly in mid-late gestation [81], although it is not clear if the prenatal exposure to the hurricane or the postnatal exposure to the recovery period, with the accompanying increased stress, is responsible. Further effects of disasters on perinatal health, particularly possible increases in spontaneous abortion, have been difficult to document and require further study [82]. Because of these known risks, programs were established by the Organization of Teratology Information Specialists and the National Center on Birth Defects and Developmental Disabilities to assist pregnant and breastfeeding women in relationship to possible exposures, such as infections, chemicals, medications, and stress, after Hurricane Katrina [83].

Newborn screening procedures were disrupted in the first month following Hurricane Katrina, as the state lab was located in New Orleans and badly damaged by the storm. However, concerted efforts to identify any lost screening samples and to locate children with positive results allowed treatment to be initiated in all 10 cases with positive screening results [84]. The newborn screening program was temporarily contracted to a different facility, such that there were no gaps in the newborn screening program.

3. Mental health

Individuals in hurricane-affected areas are often exposed to a wide range of stressors including serious risk of death, property loss, difficulty obtaining basic necessities such as food and clothing, and exposure to violence. In areas where effects linger for many months, individuals are exposed to additional stressors such as forced relocation, difficulty obtaining housing, and prolonged community disruption. Children are particularly at risk to these stressors. The effects of these stressors on children after a major hurricane event are discussed below.

3.1. Posttraumatic Stress Disorder (PTSD)

In the first 3 to 6 months following a hurricane, more than 50% of children exposed to the disaster exhibit symptoms of posttraumatic stress disorder (PTSD), disruptive behaviors, or other manifestations of psychological distress, as seen with Hurricans Hugo, Andrew, and

Katrina [85-87]. PTSD is an anxiety disorder of at least one-month duration that is characterized by symptoms of re-experiencing (e.g., intrusive memories or thoughts), avoidance and/or emotional numbing, and hyperarousal. It is often accompanied by feelings of anxiety and depression, social alienation, and mistrust of family, friends, and systems [88]. Previous research has identified exposure to disaster-related stressors as an important predictor of psychiatric symptoms among youths after natural disasters [88].

In 2008, Marsee found that 63% of students in a sample of 166 students from 9th to 12th grade had symptoms of PTSD 15-18 months post-Katrina, and that high levels of aggression were associated with emotional dysreguation [89]. In 2009, Weems et al. expanded the understanding of post-Katrina symptamology, finding that among 52 children with a mean age of 11 years in the 6–7 months following Katrina, the level of posttraumatic stress symptomatology was related to hurricane exposure, female gender, and level of predisaster anxiety [90]. The last is particularly important, as it suggests that hurricane events can serve as triggers in individuals with latent psychiatric disorders. Other variables, such as separation from a caregiver and evacuating to a shelter were associated with PTSD 2 years post-Katrina in 7-19 year-olds [91]. Caregiver symptamology is also associated with hurricane-related PTSD in children across several age groups [92, 93]. These are staggering numbers, and the extent of the challenge of caring for a major psychological disorder in the majority of the population cannot be overemphasized.

3.2. Factors influencing PTSD

Based on the newly emerging literature, PTSD following Hurricane Katrina was found to be very common, with children's responses to the stress and trauma of the hurricane event associated with other environmental and relational factors as well.

3.2.1. Age

Several studies have suggested that age has an impact on PTSD. For example, McDermott and Palmer (2002) studied 8 to 19 year olds who reported loss associated with a bushfire and reported that depression following trauma is more common in younger children than older children [94]. Similar results were found following Hurricane Hugo [95]. Other studies, however, have found differing results. Most notably, a study of adolescents in 9th-12th grades following Hurricane Katrina showed no relationship between age and traumatic response [89].

3.2.2. Gender

The majority of studies have shown that females are more likely than males to develop PTSD symptoms [95, 96]. Additionally, differences in manifested symptomatology have been described, with girls being more likely to express guilt and other emotional reactions, and boys being more likely to exhibit increased worry, anhedonia, concentration problems, academic problems and other cognitive or behavioral symptoms [95, 97].

3.2.3. Race/ethnicity

Some studies suggest that minority populations are at an increased risk for PTSD [98, 99]. This association has been found following Hurricanes as well. Following Hurricane Hugo, Lonigan et. Al. found that African American youth reported more PTSD symptoms than either Caucasian children or other minority youth [100]. Similar results were found following Hurricane Andrew, with both Hispanic and African American children reporting higher levels of PTSD symptoms than Caucasian children at 7 and 10 months post-hurricane [88]. It is important to note that it is difficult to separate the apparent effects of race/ethnicity from the effects of socioeconomic status, and rural vs urban environment. Because families that are impoverished or live in poor urban environments may be more adversely affected by hurricanes, the roles of socioeconomic status and race in PTSD requires more investigation.

3.2.4. Premorbid anxiety

Some studies have examined the influence of emotional and behavioral problems on PTSD. One prospective study conducted after Hurricane Andrew showed that pre-existing anxiety levels predicted the severity of post-traumatic responses in youth with those showing higher levels of anxiety 15 months predisaster reporting higher levels of post-traumatic symptoms 3 and 7 months after the disaster. Additionally, children exhibiting higher levels of premorbid anxiety were less likely to recover over time [101]. After Katrina, another study found that pre-hurricane trait anxiety was significantly associated with post-hurricane PTSD symptoms [102]. As hurricane events appear to cause stresses and disruptions of normal coping mechanisms, it is not surprising that children with highest pre-storm stress are most likely to develop PTSD.

3.2.5. Timescale

For many children, symptoms after natural disasters are relatively short lived, with substantial decreases occurring during the first year post-disaster [86]. For example, nearly 30% of children exposed to Hurricane Andrew reported severe symptoms of PTSD, defined as 10 or more symptoms, 3 months after the storm. At 7 months posthurricane the prevalence of such symptoms had dropped to 18%, and at 10 months posthurricane, 13% of the children still reported severe symptoms [88].

Identification of factors that distinguish children who experience chronic symptoms from those whose distress is more transient represents an important goal, given its implications for targeting postdisaster interventions. Previous research after other natural disasters has identified female sex, younger age, nonwhite race/ethnicity, parent psychopathology, and degree of stress exposure as predictors of long-term symptom elevation in youths. However, the extremely high prevelance of PTSD in the exposed population, particularly in the immediate post-storm period, also raises the possibility that universal, large-scale interventions, most likely implemented in the school setting, should also be considered.

3.3. Serious Emotional Disturbance (SED)

Serious emotional disturbance (SED) is a term that refers to children and adolescents who have a diagnosable mental disorder that results in significant impairment or decreased role functioning in family, school, or community activities. This disorder often manifests itself through aggression or other behavioral issues. While the prevalence of SED has not traditionally part of a post-hurricane evaluations, the months and years following Hurricane Katrina saw a marked increase in SED prevalence. Indeed, school referrals for mental health evaluation and services made following Hurricane Katrina were overwhelmingly for disruptive behavior disorders [103]. Moreover, the prevalence of SED following Hurricane Katrina was long-lasting: the estimated prevalence of SED among children and adolescents exposed to Hurricane Katrina 18 to 27 months after the storm was around 15%, with nearly 10% of these cases deemed by parents to be directly attributable to the hurricane [104]. And while the prevalence of SED among children and adolescents exposed to Hurricane Katrina declined to 11.5% in the next 12-18 months, this prevalence is still nearly three times greater than the pre-hurricane rate of SED (4.2%) sited in the National Health Interview Survey (NHIS) [105].

Examination of individuals with SED following Katrina indicates that approximately two-thirds of children and adolescents with SED at 18-27 months post-Katrina had recovered by the 12-18 month follow up. This recovery, however, was offset by a high rate of new SED onset during the follow-up period; more than half of SED cases at follow-up were not present during the baseline assessment [106]. Substantially more of these cases were attributable to the Hurricane, suggesting that they represent delayed onset of SED rather than normal trends in SED unrelated to the Hurricane. This delayed onset may be attributable to high levels of ongoing stress, community disruption, and other traumatic events due to slow pace of recovery in the Gulf Coast. The large number late-onset cases of hurricane-related SED indicates that there is a need for surveillance of at-risk populations than was previously thought.

Children and adolescents who experienced deficits in functioning prior to the Hurricane were more likely to have persistent SED than children without prior history. This effect was only present among youth who experienced low to moderate stress during and after the Hurricane; youth exposed to highest levels of stress exhibited elevated rates of SED, and more than one-third of these youth continued to exhibit SED at the follow up time point, regardless of previous decrements in function. Consistent with research on other disorders that imply strong associations between cumulative stressors and mental health problems, these results suggest that the magnitude of stress to which these youths were exposed was sufficient to overwhelm their coping resources. This also highlights the need for mental help for youths who experience high levels of stressors following Hurricanes.

This high prevalence suggests that the long-term, widespread impact of Hurricane Katrina on child mental health occurred on a level otherwise unseen. Further, sociodemographic factors typically associated with psychopathological reactions to natural disasters, such as age and sex [95, 98, 107], are largely unrelated to SED in children exposed to Hurricane Katrina. While the reason for this discrepancy remains unclear, it is hypothesized that the magnitude and timescale of disruption during and after Katrina increased risk for mental health problems in youths across many segments of society. Not surprisingly,

stress exposure is associated strongly with SED, and strength of association varies with traumas experienced. In New Orleans area youth, death of a loved one was most strongly associated with SED. In the remainder of children sampled, physical adversity such as difficulty obtaining food and shelter showed the strongest correlation.

Parent psychopathology has been associated with child psychopathology following major disasters, and was associated with SED following Katrina. This may predispose youth to the development of psychiatric symptoms wither through psychological predispositions or ineffective parenting (12, 29). Social class was negatively associated with SED following Hurricane Katrina. While SED is approximately twice as prevalent in children living in poverty (28), certain characteristics of the Hurricane may explain this. Damage from the Hurricane was greatest in areas of the city with high levels of poverty, and families with fewer resources would have found it more difficult to find stable shelter and other basic needs following the Hurricane. This would lead to increased and prolonged exposure of children living in poverty to a wide variety of stressors not felt by those with more resources.

Identifying the psychological and social mechanisms that underlie this complex set of associations between hurricane-related stressors and SED is an important goal for future research.

Overall, while the overwhelming majority of research into psychological effects of hurricane events has traditionally focused PTSD, research following Hurricane Katrina has shown that SED is an important disorder that needs to be considered as well, particularly in the identified at-risk individuals. That SED can present long after (i.e. more than 2 years) after a hurricane event complicates identification of affected individuals, and underscores the need for long-term surveillance of the at-risk population

3.4. Interventions

A system of psychological first aid has been developed by the National Child Traumatic Stress Network and the Department of Veterans Affairs National Center for Posttraumatic Stress Disorder. This system was employed by providers following hurricanes Gustav and Ike, and was found to improve confidence for providers and improve outcomes in adults and children [108]. For children suffering acutely from PTSD related to injuries, a combination of crisis intervention and family support was found to be most effective. It has also been noted that children possess a greater resilience and recovery power related to such events [109]. Interventions which build coping skills were found to be particularly effective [110], as were more structured cognitive-behavioral therapies [111]. Unfortunately, these therapies are complex and require special training, and given the enormous scope of the problem following a major hurricane event such as Hurricane Katrina, it can be difficult to mobilize enough trained therapist to service the affected individuals.

Elementary school-based interventions by counselors for children showing symptoms of psychological trauma was found to be effective in reducing trauma symptoms in a controlled trial [112]. This approach is particularly of interest as it allows mass application of psychological screening and therapy to a large at-risk population without relying on individuals seeking professional evaluation. Project Fleur-de-Lis was another school-based

triage and treatment program showing encouraging results utilizing a system designed to provide uniform access for a large at-risk population [113]. School-based interventions were found to be as effective as therapy through a mental health clinic [114]. Again, even with school-based interventions, the application of these techniques following Hurricane Katrina were limited to pilot studies, as adequate resources were not available to extend these interventions to all schools in the Gulf Coast area.

While effective therapies were identified, there are concerns that mental health programs were not applied globally enough, nor were they sustained in a fashion which would be required by the chronic nature of the disorders affecting children [115]. As noted above, a residual incidence of SED of nearly 15% 2 years after Hurricane Katrina underscores the need for ongoing evaluation and therapy in the at-risk population [116]. The problem is even more severe when one looks at rates of PTSD, which despite previous reports indicating the condition is temporary, remain above 40% 33 months after Hurricane Katrina, indicating that stress from the ongoing recovery efforts may have resulted in prolongation of symptoms [117]. Thus, therapy for PTSD and SED were mostly lacking following Hurricane Katrina because of lack of available mental health resources and lack of funding (estimated at $1,133 per capita expense) for comprehensive therapy for the affected population [118]. There is a clear need to develop modified therapies, particularly for PTSD, which can be implemented by personnel without advanced training in psychotherapy.

4. Conclusion

The occurrence of a large number of major hurricane events around the Gulf Coast region of the United States within a relatively short period of time has led to a dramatic increase in research in health effects of hurricane events. Some surprising results include the need for relief medical staff to be able to treat a large number of minor injuries sustained during recovery efforts, and the need to provide more urgent-care services for individuals with acute illnesses and need for ongoing care for chronic medical problems, both children and adults. As such, response teams should be better prepared to cope with a large number of individuals with more common medical complaints, rather than focusing solely on caring for individuals with major injuries incurred during the storm event. In particular, primary care physicians need to be a major part of disaster response teams, and adequate supplies of commonly-prescribed medications need to be provided as part of the disaster response.

Reports of mental health following major hurricane events reveal a shockingly high incidence of post-traumatic stress disorder and of serious emotional disturbance, affecting the majority of children in most surveys. While effective therapies have been described which can be implemented in a school setting, the capacity of trained staff to apply these therapies is overwhelmed by the scope of the problem. It is neither possible nor practical to expect that trained therapists could be made available to evaluate and treat the entire population of children in an affected area, with treatments continuing beyond 3 years from the storm event. Instead, there is a need to develop therapeutic techniques which can be applied by individuals with less

training, i.e. general physicians, school guidance counselors, or (ideally) by teachers to meet this massive need for psychiatric care following major hurricane events.

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