

DISASTER HEALTH BRIEFING

Fear-related behaviors in situations of mass threat

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ABSTRACT

This *Disaster Health Briefing* focuses on the work of an expanding team of researchers that is exploring the dynamics of fear-related behaviors in situations of mass threat. *Fear-related behaviors are individual or collective behaviors and actions initiated in response to fear reactions that are triggered by a perceived threat or actual exposure to a potentially traumatizing event. Importantly, fear-related behaviors modulate the future risk of harm.*

Disaster case scenarios are presented to illustrate how fear-related behaviors operate when a potentially traumatic event threatens or endangers the physical and/or psychological health, wellbeing, and integrity of a population. Fear-related behaviors may exacerbate harm, leading to severe and sometimes deadly consequences as exemplified by the Ebola pandemic in West Africa. Alternatively, fear-related behaviors may be channeled in a constructive and life-saving manner to motivate protective behaviors that mitigate or prevent harm, depending upon the nature of the threat scenario that is confronting the population.

The interaction between fear-related behaviors and a mass threat is related to the type, magnitude, and consequences of the population encounter with the threat or hazard. The expression of FRBs, ranging from risk exacerbation to risk reduction, is also influenced by such properties of the threat as predictability, familiarity, controllability, preventability, and intentionality.

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Introduction

An international multidisciplinary team has embarked on the study of fear-related behaviors (FRBs) in situations of “mass threat.”^{1–4} This commentary expands upon previous work that examined the detrimental effects of FRBs on the spread of disease during the 2013–2016 West Africa Ebola Virus Disease outbreak^{1–4} by considering the dynamics of FRBs in a broader context, one that also illustrates how these behaviors can be channeled to mitigate or even prevent disaster impact on human communities.

We begin by discussing 3 interrelated concepts that are introduced in the title of this commentary: fear, FRBs, and mass threats. We continue with a series of 4 disaster case examples to illustrate how FRBs operate to modulate risk. The first case summarizes our earlier work on how FRBs exacerbated risk and served as vectors for disease transmission during the West Africa Ebola pandemic.^{1–5} In sharp contrast, the second case illustrates how FRBs operated completely independently from risk during the micro-outbreak of 4 Ebola cases in the United States in 2014.^{2,4}

We then present 2 scenarios where FRBs contributed beneficially to community resilience when human populations were confronted with situations of mass threat. Case 3 describes how FRBs were effectively channeled to mobilize millions of coastal residents to participate in life-saving evacuation behaviors as Hurricane Matthew battered the southeast United States seaboard in October 2016. The final case example, Case 4, examines how FRBs were systematically orchestrated to engage tens of thousands of Fargo, North Dakota “flood fighters” in sandbagging operations to defend their city from the seasonal threat of submersion in the frigid waters of the swollen Red River of the North. This happened not once but during 14 consecutive springtime thaws that produced flood stage conditions, including the epic river rise of 2009.^{6,7}

Overview of key concepts

Fear

We begin by connecting the concepts of fear, FRBs, and mass threats. Steimer⁸ defines fear as “a motivational state aroused by specific stimuli that give rise to defensive behavior or escape.”

Fear as a protective factor

Fear is critical to species survival. Humans are recent occupants of this planet and our precarious existence owes much to the capacity to experience and react to fear stimuli. At the population level, we have noted that “fear of mass threats, including pandemic infectious diseases, is widespread, normative, understandable, and expectable.”¹ Fear reactions may potentially be directed in a preventive or protective manner to diminish risks for human exposure to disaster hazards or other forms of mass threat.

Fear as a risk factor

Fear may spread throughout a population by contagion.^{9,10} Situations where communities perceive an apparent threat to citizens’ health and welfare prompt a cascade of spiraling reactions in which fear creates fear; fear propagates fear; fear amplifies fear. Widespread fear distorts risk perceptions. Fear-laden messaging in the media may disseminate fear and distress so rapidly that fear spreads in advance of the arrival of the actual threat. Furthermore, instances abound

where public fear of mass threats is intentionally manipulated for political purposes.

Fear-related behaviors (FRBs)

This briefing adopts the following working definition for FRBs created by our research team: “*Fear-related behaviors (FRBs) are individual or collective behaviors and actions initiated in response to fear reactions that are triggered by a perceived threat or actual exposure to a potentially traumatizing event. Importantly, FRBs modulate the future risk of harm.*”^{1,2}

We have previously noted that, “when fear, ‘the motivational state,’ transforms into actions, individual fear behaviors manifest at the aggregate level and may spread rapidly and contagiously, in epidemic fashion, among groups of persons who share the fear and observe the behaviors of each other.”¹

Fear generates FRBs. As a close parallel to fear itself, FRBs may also spread across a population by contagion.¹ FRBs include actions that elevate risk and increase harm. Conversely, other FRBs are preventive or protective behaviors that act to diminish harm.

The global reach and instantaneous transmission of media and social media messaging and images may trigger seemingly spontaneous “outbreaks” of FRBs in real time and space.¹⁰ The recognition that FRBs operate in response to situations of mass threat opens opportunities for countering the expression of risk-elevating FRBs and stimulating the adoption of risk-reducing FRBs.

Mass threats

The majority of individuals are exposed to potentially traumatic events (PTEs) on multiple occasions throughout their lifetimes.^{11,12} Such events are characterized by exposure to actual or threatened death, serious injury, or assaultive violence. PTEs can be formally assessed using the Life Events Checklist (LEC-5)¹³ developed in conjunction with the American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition.¹⁴ PTEs, regardless of whether they result in physical harm, have the capacity to produce psychological distress and, with severe or prolonged exposure, post-traumatic stress disorder (PTSD). The LEC-5 includes a roster of traumatic exposures, many of which are experienced at an individual level.¹³ However, several

types of PTEs, particularly disasters and acts of mass violence, are collective, population level events.

For this discussion we will define mass threat in this manner: *A mass threat is a potentially traumatic event (PTE) that threatens or overtly endangers the physical and/or psychological health, wellbeing, and integrity of a population and that is perceived and experienced, both individually and collectively, by persons comprising the population at risk.* Case examples of mass threat scenarios selected for this commentary are drawn from the realm of disasters and extreme events that affect entire communities or larger population units.

Mass threat scenarios come in a variety of forms. Sudden-onset disasters occur with daily frequency around the globe.¹⁵ These rapidly developing, rapidly dissipating disaster events create a scattershot overlay to the backdrop of sprawling complex emergencies that evolve insidiously, developing into prolonged humanitarian crises. Underlying all, menacing existential threats, such as climate change, exert effects on such a scale that they ultimately jeopardize human tenure on this planet.

Mass threats are sometimes classified using some form of disaster taxonomy that distinguishes so-called “natural” disasters from “human-generated” (“anthropogenic”) events.^{16,17} Natural disasters are classified into several subcategories such as meteorological (e.g. thunderstorms, tornadoes, tropical cyclones), hydrological (e.g., floods, tsunamis, mudslides), climatological (e.g., heat/cold waves, wildfires), geophysical (e.g., earthquakes, volcanoes, landslides), and biological (e.g., human pandemics, crop/livestock diseases).

Human influence is now so pervasive throughout the planet that many geological and environmental scholars are declaring the end of the Holocene epoch of the past 11,500 y and the ascendance of “The Anthropocene.” Human influence is especially prominent in the realm of disasters and mass threats. In tandem with this view, the term, “anthropogenic disaster,” is supplanting its predecessor, “human-generated disaster.”

Anthropogenic events may be further dichotomized into non-intentional and intentional. Non-intentional anthropogenic events usually involve a failure or malfunction of human technology (hence, “technological disaster”). Examples include transportation crashes, structural collapses, and hazardous materials spills.

In contrast, intentional anthropogenic events are perpetrated actions. When scaled up to the population

level as acts of terrorism and mass violence, these attacks qualify as disasters. Intentional mass threats may be dissected even more finely into chemical, biological, radiation, nuclear, and explosive or incendiary (CBRNE) variants.

Characteristics of situations of mass threat that interact with fear reactions and influence trauma exposure

Mass threat scenarios differ by type (e.g., natural vs. anthropogenic) and scale, including quantifiable measures of magnitude or intensity of destructive force, geographic scope, and duration of impact. Also important is the size and makeup of the affected population. Threat scenarios are also distinguished by the degree and extent of consequences measured with a variety of metrics including mortality, injury, disease spread, economic costs, loss of resources, and degree of social disruption.^{18,19}

Specific to the expression of fear and FRBs, other qualities of the threat scenario are important to consider: predictability, familiarity, controllability, preventability, and human causation (intentionality).^{18,19}

Case examples of the operation of fear-related behaviors

Four case examples will illustrate a range of presentations of FRBs in situations of mass threat. As will be described, in sequence, FRBs may 1) exacerbate harm, 2) operate independently from harm, 3) mitigate harm, or 4) prevent harm.

Case 1. Fear-related behaviors (FRBs) operating to increase risk and exacerbate harm: The 2013–2016 West Africa Ebola Virus Disease Outbreak

Disaster classification: An international viral zoonotic communicable disease epidemic (pandemic) affecting large human populations on a scale that qualified as a natural biological disaster. This pandemic escalated into a protracted complex emergency and humanitarian crisis with mass morbidity and a high case-fatality rate.

Background

The 2013–2016 West Africa Ebola Virus Disease (EVD) outbreak was unmatched in scope and scale on multiple quantifiable dimensions. The outbreak

exemplified the concept of a mass threat. Among the 25 recognized EVD outbreaks over the 40 y since the discovery and identification of Ebola in 1976, this was the first and only outbreak to “go global” and fulfill the criteria for a “pandemic.”⁵ Furthermore, this outbreak was one of only 4 infectious disease events in history to be declared a “public health emergency of international concern” (PHEIC) by the World Health Organization (WHO).

Particularly distinguishing were the unprecedented EVD surveillance tallies.⁵ More than 28,600 persons became ill with EVD during the pandemic, representing 12 times more cases of Ebola than occurred in all 24 other outbreaks combined. The 2013–2016 epidemic produced mass mortality, equivalent to a 39.5% case-fatality rate (interpretation—4 of every 10 EVD patients died). The total of 11,300 deaths was 7 times the combined death toll from all other EVD episodes taken together.⁵

Most notably, the 2013–2016 EVD pandemic produced 21 times more survivors than all other outbreaks together. More than 60% of EVD cases, an estimated 17,300 persons who became ill with EVD, recovered from disease. This was the sole EVD episode where survivors represented a significant subpopulation for ongoing public health surveillance. During 24 prior EVD outbreaks, a cumulative total of only 816 persons had survived their illnesses.⁵

These unique epidemic features, characterized by a triplet of extremely elevated counts for EVD cases, EVD fatalities, and survivors, contributed to rampant Ebola fears and the FRBs that ensued.

Fear-related behaviors

The 2013–2016 EVD outbreak served as the test bed for our researchers to explore the operation of FRBs in situations of mass threat. During the outbreak, FRBs were implicated in 1) accelerating the transmission of Ebola virus, leading to the epidemic spread of EVD cases and associated deaths; 2) impeding the willingness of persons with Ebola illness to seek life-sustaining care provided through a network of specialized Ebola treatment units (ETUs) erected throughout the intense transmission nations in West Africa; 3) curtailing access and diminishing the patronage of medical services for treatable non-EVD conditions such as malaria, HIV, and tuberculosis; 4) increasing risks for Ebola-related psychological distress that sometimes progressed to new-onset psychiatric disorders; and 5) generating downstream cascades of societal stigma, discrimination, and social problems.

Preliminary explorations on the part of our team of investigators produced a set of 9 FRBs, subsumed under the preceding 5 categories of public health and psychosocial consequences.¹

First, 3 well-documented FRBs contributed to the epidemic spread of Ebola virus infection. Most notably, family members of Ebola patients harbored and cared for loved ones in home settings. Often the care was provided in a clandestine manner, shielding these cases from the authorities. Untrained family caregivers lacked proper personal protective equipment. They lacked knowledge and skills regarding infection control practices and procedures. In-home care caused explosive spread of Ebola virus, leaping from household to household, and accounted for more than one-third of Ebola cases.

Patients frequently died in the same home settings where their care had been provided and where their caregiving relatives were becoming infected. With high frequency, the extremely infectious cadaver of the deceased was cleansed and prepared for burial by the bereaved family members in the household, aided by extended family members from outside the home. Viral transmission was hastened by the observance of these traditional hands-on customs.

As an apparently rational decision, some groups attempted to flee from areas of high Ebola incidence by migrating to areas perceived to be safe from the disease. Unfortunately, among the migrants were infected persons who were initially asymptomatic when they set out on the journey. Within days they developed active, transmissible illness and spread disease among their comrades while all were trying to outrun the epidemic. Ironically these groups sometimes introduced Ebola into previously virgin territories.

Second, 2 FRBs were identified that impeded access to, and use of, life-saving EVD treatment in the ETUs. The most obvious was the purposeful avoidance of the ETUs based on what was outwardly observed (patients entering the ETUs and not returning alive) and what was believed based on fear-infused misinformation and rumor (patients were being harmed by the health care personnel working in the ETUs).

Also, in contrast to the heroism shown by thousands of health care workers who risked their lives to treat Ebola patients, often paying the ultimate price of death in the line of duty, many other health workers opted not to work at such extreme risk to self and family. Health care worker attrition due to a combination of death, disability, and defection hobbled the already-understaffed health

care system. By necessity, the ETUs relied heavily on foreign health professionals.

Third, fear of seeking health services generalized from avoiding the ETUs to also foregoing medical care for serious but treatable non-Ebola conditions. Unfortunately, this FRB—avoiding non-Ebola medical care—carried deadly consequences. It was estimated that preventable deaths from inadequately treated cases of HIV, tuberculosis, and malaria, plus unnecessary maternal and infant deaths associated with unattended childbirths, were equal in number to all EVD deaths combined—almost 11,000.²⁰

Fourth, 2 related FRBs elevated risks for psychological distress and psychiatric disorders, particularly for specific groups. Ebola survivors and health care workers were both blamed for spreading the virus and targeted for discrimination and harsh treatment. This was the first EVD outbreak in history to produce a large subpopulation of survivors. These individuals who recovered from EVD were subjected to extreme stigma, discrimination, blame, and abuse. Only later in the outbreak were these behaviors partially offset by programs to “heroize” survivors and to actively recruit them to serve in the ETUs where, due to their acquired immunity, they could work safely with EVD patients. A related FRB, also based on misinformation and misdirected beliefs, involved stigmatizing and even attacking health workers and their family members.

Fifth, and finally, at a regional, national, and international level, stigma was heaped upon the intense transmission nations of Guinea, Liberia, and Sierra Leone. These actions led to isolation and ostracism of entire nations, and their products and peoples, and set off a spiral of social and economic consequences.

We have previously provided a detailed and documented description of these FRBs.¹ The team is currently embarking on modeling and quantifying FRBs for the EVD outbreak.¹ This exercise will serve the dual purposes of documenting the role of FRBs in a specific instance and calibrating the process for identifying and measuring the impact of FRBs.

Case 2. Fear-related behaviors (FRBs) operating independently from risk. The 2014 Ebola Virus Disease “Micro-Outbreak” in the United States

Background

The US experience during the 2013–2016 EVD outbreak presents a startling contrast to West Africa.

Juxtaposed against the largest EVD outbreak on record, one that dwarfed all prior outbreaks combined, the United States experienced a “micro-outbreak” of 4 cases during October 2014 that was completely circumscribed in time and place.

The index case was a Liberian citizen who became infected but was not yet symptomatic when he arrived to visit family members in Dallas. Several days after his arrival, he sought admission to Texas Presbyterian Hospital when symptoms appeared. Despite receiving treatment, he died in the hospital one week later. He was the first EVD case to enter the US undetected and develop symptomatic Ebola illness inside the US. Two nurses who cared for him were infected in the line of duty and both developed EVD. These two nurses were the first 2 direct transmission EVD cases, and also the first 2 health care worker cases, in the US. A physician who volunteered his medical services in West Africa was diagnosed with EVD upon his return to New York City, becoming the fourth US case. The three health care professionals were treated in specialized facilities and all 3 survived and recovered. Four cases. One death. End of outbreak.

Fear-related behaviors

Ebola fear was widespread despite the reality of a miniscule number of cases. The hallmark of the US EVD experience was a frenetic contagion of fear surging through the US population, in the absence of disease risk.^{2,4}

Ebola was the top news story during October 2014 and constant media coverage also boosted Ebola to “top of mind” status. FRBs in the US were elegantly modeled mathematically by Towers and colleagues.¹⁰ These investigators found that, throughout the month of October 2014, Ebola-related news video broadcasts on major networks set off immediate cascades of Ebola-related Internet searches and flurries of fearful Tweets.¹⁰ Media stories were the drivers of these behaviors that revealed widespread concern, unrealistic perceived risk (searching “Do I have Ebola?”), and outright fear.¹⁰

The media-viewing US population received a continuous bombardment of Ebola stories. Such indirect exposure, portraying Ebola as a PTE, and raising the specter that the US could become the next West Africa, undoubtedly affected psychological health in the US. Indeed, researchers have determined that levels of psychological distress increase when viewing

traumatic events on television. On a population basis, such exposure may lead some viewers to develop symptoms of acute PTSD.^{21,22} In tandem with the ongoing media fusillade, multiple surveys conducted by news and media organizations in the US documented widespread public fear compounded by strongly-held beliefs in personal and national susceptibility to this deadly disease.²³

Fortunately, with no circulating Ebola virus, there could be no FRBs implicated in EVD spread. Instead, the US witnessed rampant fear disconnected and decoupled from risk for disease.¹⁰ However, this phenomenon of media-potentiated fear responses is highly instructive in terms of one type of positive FRB. The four-case outbreak in the US served as an “inoculum” and a wake-up call for improving infectious disease and bioterrorism preparedness. Significant federal funding was allocated to upgrade the hospital and public health pandemic preparedness capacity, including nationwide training for health care workers. Unlike West Africa, important flaws and weaknesses in US protocols and procedures were revealed and redressed at no human cost.

Case 3. Fear-related behaviors (FRBs) motivating protective actions. The 2016 Impact of Hurricane Matthew along the Southeast US Coast

Disaster Classification: Natural meteorological/hydrological disaster involving major hurricane winds, deluging rains, and coastal/storm surge interacting with periodic high ocean tides.

Background

Hurricane Matthew was the most powerful tropical cyclone during the 2016 Atlantic Hurricane Season with impacts occurring across a massive swath of the Atlantic Ocean and the Caribbean and spanning latitudes ranging from the north coast of South America to the Canadian Maritimes. The focus of the present discussion is on US citizens living in the states of Florida, Georgia, South Carolina, and North Carolina (listed in order of impact for this northward moving system).

Prior to Matthew’s arrival along the Florida coast, the storm had impacted several island states in the Lesser Antilles, northern coastal areas of Venezuela and Colombia and the ABC islands, Hispaniola (Haiti and the Dominican Republic), eastern Cuba, and the

entire expanse of the Bahamas Islands. Haiti, in particular, had sustained severe and deadly consequences.

The system approached Florida at Category 4 intensity and tracked very close to the coastline but remained offshore with the storm center coming within 12 miles of the Kennedy Space Center. By remaining over water, Matthew retained strength and created heavy wave action along the entire length of the Florida peninsula. Particularly in the area of Daytona Beach, the shoreline areas were particularly susceptible to flooding due to a combination of the close storm approach, wave action, storm surge, deluging rains, and high tides. However, the strongest storm winds remained over open water and there was no landfall in the states of Florida or Georgia. Once the storm came ashore near McClellanville, South Carolina, winds had diminished to Category 1 strength. Matthew was the first hurricane to make landfall in the US since 1954.

More than 2 million persons lost power. There were 49 storm-associated fatalities with more than half of the deaths in North Carolina, a state that sustained minimal wind impact but dealt with massive downpours and inland flooding.

Fear-related behaviors

Matthew’s strength, late-season timing, and geographic positioning set multiple records. Understandably, the approach of such a powerful hurricane generates fear reactions. Fear may be widespread days in advance of impact for millions of citizens who are projected to be in the storm’s path. Fear was understandable and underscored in this case by coverage of Matthew’s devastating effects on populations that experienced the storm in Haiti, leading to hundreds of deaths, and in Cuba and the Bahamas. There was no doubt that Matthew packed destructive potential as it accelerated toward the US mainland.

However, offsetting the expectable fear reactions were several characteristics of tropical cyclones that allow potential harm to be mitigated. Hurricanes are predictable in terms of path and their approach can be forecast days in advance, allowing citizens to prepare their homes and take life-saving precautions. For citizens living in the southeast US, hurricanes are also familiar events that many residents have previously experienced and successfully survived. These states have implemented strong building codes to minimize damage to property.

Governors of the 4 states that ultimately sustained a direct encounter with Matthew issued emergency warnings and evacuation orders with ample time for citizens to comply. State emergency management and law enforcement personnel facilitated the evacuation logistics according to well-rehearsed protocols. For example, in Florida, the Governor admonished more than 1.5 million citizens residing on barrier islands and low-lying coastal areas to evacuate inland. The storm's path was accurately forecast to move northward along the coast, but not to venture inland, so evacuation westward, away from Florida's Atlantic coastline, would assure safety. The uncertainty regarding whether the storm would track directly along the coastline, thereby causing maximal damage, added incentive to the evacuation orders.

In this instance, the behavior of heeding the evacuation orders can be considered to be a protective FRB that literally moved citizens away from the life-endangering forces of wind, storm surge, and heavy precipitation. Throughout the storm-affected southeastern states, several million persons evacuated without harm and most were able to return unscathed to their coastal properties several days later.

Case 4. Fear-related behaviors (FRBs) motivating disaster prevention: The 2009 Red River of the North Flood at Fargo, North Dakota

Disaster Classification: Natural hydrological river valley and overland flood disaster related to seasonal thawing of winter snowpack.

Background

There are uncommon instances where it is possible to mitigate disaster hazards so completely that human impacts of an imminent threat are not just mitigated but actually prevented. This requires the rare coincidence of 2 conditions: 1) the ability to accurately pinpoint the future occurrence of a hazard in time and place, and 2) the ability to take effective actions to decrease the risk.

Fargo, a Midwestern US city of 105,000 residents, is situated in the shallow basin-shaped Red River Valley, along the west bank of the north-flowing Red River of the North. Most years, particularly following heavy winter snowfalls, the river begins to thaw near Fargo in late March while the mouth of the river, far north in Canada, remains solidly frozen, providing no outlet.

Consequently, the melting snowpack swells and overflows the Red River, creating a flood threat for Fargo. The Red River Valley experienced a prolonged "wet cycle" and every spring, from 1997 through 2011, the Red River at Fargo reached flood stage conditions.

Fear-related behaviors

Fear supplies the motivation, thus prompting persons in harm's way to engage in FRBs that successfully fend off the hazard. This has been powerfully documented in the case of "community-involved mitigation of river flooding" in Fargo, North Dakota, USA.^{6,7}

For Fargo citizens, fear of flooding is a part of the culture. Fargo residents have vivid memories of the Red River Valley Flood of 1997, the "great flood," when portions of Fargo were submerged in icy water. Thereafter, citizens took vigorous action to prevent a recurrence. During the next 14 years, the Red River at Fargo exceeded flood stage every year. Since the time of the great flood, Fargo citizens have come together every spring in a well-rehearsed ritual of sandbagging and constructing dikes and levees along low-lying riverbanks and vulnerable structures to prevent flooding of the city.

Fear is a motivator, but with the ability to predict and respond to the threat, FRBs have emerged as collective actions that protect the city and also give the citizens a proud identity as successful "Flood Fighters." In this case, the fears are titrated and the flood mitigation activities are hallmarks of exemplary community resilience.

The most harrowing and fear-provoking year for Fargo residents was the record peak in 2009 when the river crested at 24 feet above flood stage. No one knew whether the community could build flood fortifications that would withstand a river rise of this height. A single breach in the levees would result in citywide flooding. With sub-freezing temperatures and sporadic blizzard conditions in late March, the sandbagging operations were based in the heated Fargo Dome, the city's largest indoor environment. As the river waters rose, 85,000 individuals participated in filling the sandbags in the Dome and placing the sandbags along the riverbanks. In this unprecedented race against the river, more than 8.5 million sandbags were filled, transported, and placed strategically. Fortunately, the precarious sandbag barriers held back the glacially-cold waters of the Red River of the North. Overland flooding was visible for miles in all

Table 1. Distinguishing characteristics of fear-related behaviors in case examples of mass threat scenarios

Distinguishing Characteristics	2013–2016 West Africa Ebola Pandemic	2014 US Ebola Micro- outbreak	2016 Hurricane Matthew US Impact	2009 Red River Flood in Fargo ND
TYPE AND IMPACT OF THE MASS THREAT				
Mass threat situation	Yes	No	Yes	Yes
Mass threat type	Biological: Pandemic	Biological: Outbreak	Meteorological: Major hurricane	Hydrological: River flooding
Magnitude	Worst EVD outbreak in history	4-case rapidly contained outbreak	Category 4 hurricane	Record river rise
Level of population disruption	Extreme	Minimal	Very high	Very high
THREAT DESCRIPTORS				
Predictable threat	No	No	Yes	Yes
Expectable threat: Pre-impact warning	No	No	Yes	Yes
Familiar threat	No	No	Yes	Yes
Controllable threat	No	Yes	Yes	Yes
Malicious human intent	No	No	No	No
INTERACTION OF THE THREAT AND FEAR-RELATED BEHAVIORS (FRBs)				
Fear level	Extreme	Very high/ disproportionate	Very high	Very high
Role of FRBs and risk of harm	Exacerbating risk	Independent of risk	Decreasing risk/Protective actions	Decreasing risk/preventive actions
FRBs that increased risk	In-home care Contact with cadavers Fleeing area Avoiding EVD treatment Avoiding non-EVD treatment Stigma/discrimination	Unrealistic fear Internet searches/Tweets		
FRBs that moderated or decreased risk		Improving health care pandemic preparedness	Emergency activation Coordinated coastal evacuation Protection of special needs populations	Emergency activation Coordinated citizen actions Sandbagging operations Community psychosocial support
Media messaging that increased risk		Media-driven fear messaging	Fear-amplifying weather reports	Public warnings
Media messaging that moderated or decreased risk	Public health communications	Public health communications	Public warnings Guidance for evacuation	Guidance for sandbagging operations Reassurance from public officials Psychosocial messaging
FRBs can mitigate threat	No	Yes	Yes	Yes
FRBs can prevent threat	No	No	No	Yes

directions but the city of Fargo remained a dry oasis surrounded by water.

In this illustration, disaster prevention was achieved. Fears were redirected into constructive, preventive “flood-fighting” FRBs that succeeded in erecting an impenetrable fortress of levees around the perimeter of Fargo. These actions, these FRBs, invigorated the social fabric of the community and bolstered community resilience.

Discussion and concluding comments

As further advancement on the conceptualization of FRBs, this paper examines a wider range of mass threats and associated FRBs. Fear reactions and FRBs vary based on the nature of the threat and the availability of knowledge and behavioral options for dealing with the fears (Table 1). The four scenarios presented to illustrate the operation of FRBs can be compared based on the type and impact of the mass threat, key threat descriptors, and the interaction between the threat and the FRBs.

Type and impact the mass threat

The degree of fear experienced relates to the type, magnitude, degree of harm, and destructive potential of the threat.

Threat descriptors

Fear reactions and psychological consequences also tend to be more severe in situations where the threat, or the exposure to the hazard, is unexpected (no warning period), unpredictable, unfamiliar, uncontrollable, or unpreventable.

Interaction between the threat and FRBs

In Table 1, the final block of items compares the 4 scenarios in terms of the level of fear and, most importantly, the role of FRBs in relation to risk or harm. We observed a situation where FRBs exacerbated and magnified the risk for harm as described in our work with the West Africa EVD pandemic. This is contrasted with the situation of the 4-case Ebola outbreak in the US where FRBs, involving population-wide distress stemming from perceived vulnerability to Ebola virus infection, operated completely independently from the true, negligible risk for exposure to Ebola. Further contrasts are highlighted with scenarios that demonstrate how FRBs can be managed in a protective manner to engage large populations

in life-saving evacuation behaviors, prior to the arrival of Hurricane Matthew, and effective “flood fighting” to safeguard the Fargo river community from rising flood waters.

This is the first paper to extend beyond our initial description of the harmful effects of FRBs during the Ebola pandemic and to present a wider spectrum of possible presentations of FRBs. Our research team is currently moving toward modeling and quantifying FRBs. Future work will explore approaches to diminishing the harmful effects of risk-elevating FRBs and promoting the expression of risk-reducing FRBs.

Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

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