Chapter 36

TERRORISM AND CHEMICAL, BIOLOGICAL, RADIOLOGICAL, NUCLEAR, AND EXPLOSIVE WEAPONS

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INTRODUCTION

Chemical, biological, radiological, nuclear, and explosive (CBRNE) agents have gained increased international attention in the last 20 years. In 1992 Boris Yeltsin, the Russian president, admitted for the first time that the Soviet Union had continued to develop an offensive biological warfare program following the Soviet Union's ratification of the Biological and Toxin Weapon Convention in 1972.[1] In 1995 the world was stunned by two major terrorist attacks. In March the Aum Shinrikyo cult carried out a large-scale sarin attack on the Tokyo subway system. In April two home-grown American terrorists, Timothy McVeigh and Terry Nichols, attacked the Murrah Federal Building in Oklahoma City, Oklahoma, with a large truck bomb. Early in the new millennium on September 11, 2001, the terrorist group al Qaeda attacked the Pentagon and the twin towers of the World Trade Center. Although the anthrax mail attacks followed within the week, they were not recognized until October, when the first victim fell ill. In the midst of these terrorist attacks, an emerging infectious disease outbreak caused by a new contagious disease called severe acute respiratory syndrome (SARS) appeared and caused widespread death and illness around the globe, including in China, Taiwan, Hong Kong, Singapore, Vietnam, and Canada. Although not a terrorist attack, the SARS epidemic resembles what might happen following a terrorist attack with a contagious disease such as smallpox.

CBRNE weapons are no longer weapons only of states; they have become available to terrorists as well. Many experts believe that a large-scale attack with CBRNE weapons is not a matter of if, but of when. Therefore, it is critical that mental healthcare practitioners become aware of the possible psychological consequences following a CBRNE attack.

The psychological effects differ from other medical effects in that personnel do not need to be physically exposed to these agents to exhibit symptoms. Psychological effects can cause symptoms that may mimic the prodromal (or early) symptoms of CBRNE agents. Fortunately, the acute and long-term effects after CBRNE attacks have no apparent unique psychological disorders, but rather seem to exist on a continuum with effects seen after natural disasters or high explosives.[2] Psychophysiologic effects, typically syndromes of medically unexplained symptoms, will likely dominate the long-term picture,[3] and treatment may be difficult because of patient resistance and difficulties with doctor–patient relationships.[4]

This chapter will not be a comprehensive review of the literature; rather, it will introduce the clinician to potential problems resulting from CBRNE attacks. The chapter will briefly cover some unique aspects of such attacks, which can amplify the psychological effects, before reviewing acute and long-term effects.

TERMINOLOGY

Terminology has an important effect on perception. Having a name for something presupposes an understanding. Terminology can be positive, neutral, or negative, depending on the connotations and context. One important collective behavior phenomenon has variously been called mass hysteria, epidemic hysteria, and mass psychogenic illness.[5–7] Unfortunately, these terms have a pejorative connotation. For example, hysteria comes from the Greek word *hystera*, meaning uterus. Thus, when "mass hysteria" is used to describe an event involving medically unexplained physical symptoms, the immediate presupposition is that mostly females are involved. The common connotation for hysteria presupposes an overemotional response to an event, that is, a pejorative connotation. Use of "mass hysteria" by media, medical personnel, or public officials can lead to a negative perception of medical personnel and public officials by people affected by an event and vice versa. Similarly, in "mass psychogenic illness," *psyche* refers to the mind and *genic* refers to genesis or creation. The connotation is that symptoms are "all in the head" and thus not real. A preferred term is "outbreak of multiple unexplained symptoms" (OMUS).[7] Although clumsy, this term is relatively neutral. OMUS is also descriptive—the symptoms are real but unexplained, rather than "all in the head."

Another common term used in CBRNE events is "worried well." This terminology presupposes that the "worried well" are not suffering a real medical effect from a CBRNE exposure, but are simply worried that they might be ill. However, after a CBRNE event, many people with unknown exposures may be symptomatic—distressed and in pain. How can they be "well?" Again, "worried well" is a pejorative term and should be discarded. In the 1950s a more useful term, "disaster fatigue," was used. This term was based on the military experience with combat exhaustion or battle fatigue (now called combat stress reaction). In World War II, battle fatigue was originally called "war neurosis" or "psychoneurosis" (which also had a negative connotation for soldiers).

Panic is another commonly used term, often used in reference to the general public, that is, a "mass panic." In the strict sense, mass panic means an acute fear reaction marked by loss of self-control and followed by nonsocial and unreasoning flight.[8] Flight can be a normal reaction to the presence of an immediate danger. It becomes a mass panic only when large numbers of people stampede without regard to others in an attempt to escape danger. Thus, to describe a panic following the anthrax attacks in 2001 or the New York City outbreak of West Nile virus in 1999 is inaccurate because there was no mass exodus from any city, nor was there an explicit danger from which to escape. A more accurate term would be "mass anxiety."

Terrorism and CBRNE incidents (whether in warfare or in terrorism) are most typically mass casualty events (MCEs). However, MCEs vary widely both in the number and severity of casualties and the ability of the local environment to respond to the event. One group has proposed a useful terminology that categorizes MCEs into emergencies, disasters, and catastrophes based on the demand characteristics (number of people in need of rescue, shelter, or medical treatment) of the event and the locally available response capacity.[9] Disasters are events in which the demands are in excess of the locally available response capacity (eg, the 2001 World Trade Center attack). Although emergencies may have high demand characteristics, they are not disasters because the locally available response capacity can handle the demand (eg, the 2001 attack on the Pentagon). Catastrophes occur when the event not only overwhelms the local response capacity, but also causes substantial damage to the infrastructure supporting the response system (eg, the 1995 Kobe earthquake in Japan).

Persistent idiopathic (medically unexplained) symptoms that drive patients to seek medical care[4] typically fall within syndromes, including chronic fatigue syndrome, fibromyalgia, and multiple chemical sensitivity. These syndromes have overlapping symptom clusters and may be identified more by the specialty of the physician providing treatment than by the patient's symptoms.

RISK COMMUNICATION AND PERCEPTION

Communicating With the Public

In a CBRNE event, it is likely that the extent of the danger will not be known immediately, especially for chemical, biological, radiological, and nuclear (CBRN) weapons. Public health authorities and public officials will attempt to calculate the extent of the threat, and inform the media and the public. New York City Mayor Rudolph Giuliani was extremely effective following the events of September 11, 2001, and demonstrated the value of daily or twice-daily scheduled briefings with the media and the public. Much has been published on principles of health communication, including having a consistent message delivered by a knowledgeable and credible official, listening and responding to the concerns of the public, and avoiding the appearance of defensiveness or concealment.

After any toxic accident or terrorist attack, many people will feel anxious about the potential health effects of a CBRN release. Such anxieties may be multiplied if devastating descriptions of the potential aftermath appear in the media. Following the 2001 events, fears were exacerbated by media suggestions that in an anthrax attack, "your next breath may kill you." Public officials should provide accurate hazard communication and workable measures that can be taken to protect individuals and families. According to one risk communication approach, risk equals hazard plus outrage.[10] Hazard is the scientifically based risk assessment, but outrage is made up of nonquantifiable factors related to the public's concern and perception of the event. Outrage following an attack with weapons of mass destruction will significantly influence both acute and long-term psychological effects.

The US Army Center for Health Promotion and Preventive Medicine has more detailed information and training courses available (see the Center's Web site: http://usachppm.apgea.army.mil/risk/). The Centers for Disease Control and Prevention has developed a course on emergency risk communication training (see the CDC's Web site: http://www.cdc.gov/cdcynergy/emergency/).

Risk Perception

Risk perception is an important driver of the outrage component in risk communication. CBRN weapons involve a number of factors that can increase the perception of risk. Many CBRN weapons are invisible and odorless (radiation, biological agents, and some chemical agents), which leads to uncertainty about both exposure and amount of exposure. In many cases, exposure is not known until the patients become symptomatic. However, these agents may initially induce nonspecific symptoms (eg, fatigue, headache, nausea, dyspnea, dizziness, and muscle and joint ache). Regardless of illness induced, chemical agent and radiation exposures will also increase the fear of the long-term effects of the exposure.

In the risk literature, a number of factors have been shown to increase the perception of risk, including potentially fatal illness, involuntary exposure (lack of control), a catastrophic event, presence of an unknown perpetrator, delayed detection and reaction by authorities, and potential effect on future generations.[11,12] Fear of radiation, in particular, is prevalent, largely because of ignorance and misinformation. Thoughts and images typically associated with radiation are death, cancer, sterility, and fear for future generations. A number of factors may further amplify risk perception: scapegoating, distrust of governmental and industrial experts, and news media hype and misinformation.

Mass Media

The acute and long-term consequences of terrorism and CBRNE events are certainly shaped by risk perception. Risk perception, at least in part, is shaped by the mass media. Mass media has played an important role in various OMUS situations.[13] Media are an important risk amplifier because they select and frame risk messages to inform the public, and intensive reporting (or media hype) can create continuing waves of news.[13]

The power of the media can be seen in studies that followed both the 1995 Oklahoma City bombing and the events of September 11, 2001. In a study of over 2,000 middle-school children surveyed 7 weeks after the Oklahoma City bombing, both emotional exposure and television exposure were significantly related to posttraumatic stress symptomatology.[14] When children with no direct (felt or heard the explosion) or emotional (knew someone killed or injured) exposure to the bombing were divided into high and low television exposure, children with high television exposure had significantly higher posttraumatic stress scores.[14] A telephone survey study done 3 to 5 days after September 11 found that 44% of the people surveyed had one or more substantial stress symptoms, including sleep difficulties, irritability and anger, difficulty concentrating, and disturbing thoughts, memories, and dreams.[15] The people responding to this survey were not present at the event; therefore, much of what they knew was presumably based on media reporting.

In a contagious disease outbreak, information becomes extremely important. The public is eager for information and needs to know what precautionary measures should be taken. In Hong Kong, most respondents to a survey reported actively seeking SARS information on a daily basis, and relied more on mass media (television, newspapers and radio) than on medical professionals, friends, or the Internet.[16] Substantial misinformation and false beliefs persisted among Hong Kong adults even at an advanced stage of the SARS epidemic, despite constant media and public service announcements.[17] Recommended measures were not practiced uniformly. Many people did not understand transmission routes; only one third of respondents avoided direct contact by touch with contaminated objects (fomites), and less than one half practiced at least five of the seven recommended precautions.

TRIAGE AND ISSUES OF DIFFERENTIAL DIAGNOSIS

An important lesson learned from the Israeli Scud missile experience is the importance of a separate stress center at hospitals, so that psychological casualties can be removed from the emergency room and taken to a less stressful environment. Only recently have neuropsychiatric casualties been included as a triage category.[18] When Israel was attacked with Scud missiles during the Persian Gulf War in 1991, large numbers of people reported to the emergency room for treatment.[19,20] Studies reported that approximately 70% to 80% of the patients in the early attacks had stress-related symptoms.

Psychological Symptoms

Many symptoms commonly seen following a CBRNE incident (fatigue, nausea, vomiting, headaches, and anorexia) are common in combat[21] and can be induced by acute radiation sickness (ARS) and chemical agent exposure, or during the prodromal syndrome of exposure to various biological agents and toxins.[22] Because many CBRN agents are invisible, many soldiers may experience symptoms that they blame on CBRN exposure, regardless of actual exposure or dose of exposure. These patients are not "worried well." They are worried—possibly with good reason—but they are not well if they are in distress and pain.

Some CBRN agents may directly induce psychological effects in addition to medical effects (eg, nerve agents can induce anxiety).[23] In other cases, symptoms may precede signs; that is, patients exposed to pulmonary agents may initially present with respiratory distress without measurable physical signs.[24] Symptomatic ambulatory cases with mild or perceived exposures will present difficulties for CBRN event triage.

Unfortunately, most disaster exercises for CBRNE or other incidents include few psychological casualties. Without proper training based on actual CBRNE accidents, incidents, and attacks, healthcare providers will be unprepared for the sudden onslaught of patients presenting with mild or psychological symptoms who will arrive at the hospital before the severely wounded.

Estimating Psychological Casualties

Based on historical experience in World War II, military medical planners can get a rough estimate of battle fatigue or combat stress casualties, based on the number of wounded in action (WIA) expected from different types of battles.[25,26] In World War II, the ratio of combat stress casualties to WIA was in the range of 1:10 to 1:2.[25,26] The civilian psychological casualty (PC) to WIA ratio for the first Israeli Scud missile attack was 16:1 (if PCs are combined with unjustified atropine injections) or 8:1 (if only the PCs are included). In the 1987 radiological contamination accident in Goiânia, Brazil, where no explosion occurred, the PC to WIA ratio was 500:1 (with WIA defined as anyone contaminated either externally or internally), or 2,500:1 (with WIA defined as those individuals requiring close medical surveillance).

Both examples involve civilians of two foreign nations, so extrapolation to US citizens or military personnel is difficult. The available data suggest that it is unlikely that the PC to WIA ratio following a CBRNE attack or incident will resemble the 1:10 to 1:2 range seen in World War II battles. The low end of the range may resemble World War II statistics, but the high end could go much higher, depending on the characteristics of the CBRNE attack. Most importantly, it is time to ensure that training for disaster and CBRNE incident should involve large numbers of psychological casualties, not the typical token few.

ACUTE EFFECTS

Mass Panic

The common image of behavior during or after a disaster is that of mass panic, described as "highly disorganized flight by hysterical individuals who have stampeded at the sight of actual or potential danger."[27(p68)] During the Cold War, civil defense planners feared that a mass panic would follow a nuclear attack. However, studies of disasters and wars over the last 50 years show that disorganized flight (mass panic) is very rare.[28–30] The few occasions when it did occur were very circumscribed and were characterized by limited escape routes with the possibility of entrapment, a perception of collective powerlessness, and a feeling of individual isolation.[27,29,31] The most frequent historical examples of mass panic are in cases of fires, mine collapses, and sinking ships. Mass anxiety is *not* mass panic.

In the initial use of chlorine gas on the Western front by Germany in 1915, "a full-blown, blind, contagious panic swept portions of the line."[32(p91)] However, no panic occurred farther out on the line where there was little or no gas. In the next six gas attacks over the following 2 months, no mass panics occurred, although protective equipment was rudimentary and not widely available. Only four other gas panics were documented in World War I.

Most victims of the Tokyo sarin subway attack were office workers going to their jobs in central Tokyo. Despite the crowded conditions of the morning rush hour and the limited escape routes, there were no reports of mass panic. One fireman reported a "perplexing silence" at the accident scene—no talking, just the coughing of the victims as they awaited medical assistance.[33]

Distress and Outbreaks of Multiple Unexplained Symptoms

Perceived exposure to a CBRNE agent can result in the appearance of symptoms that may be hard to differentiate from mild symptoms expected from actual exposure. Thus, an OMUS can occur independently or in conjunction with a CBRNE event. However, in a CBRNE event, not all symptomatic casualties have been exposed to a toxic agent.[34] Symptoms of psychological origin can also occur in casualties actually exposed to a CBRNE agent and may make treatment more difficult (victims finding out they have been exposed to a lethal disease such as anthrax or smallpox are unlikely to remain calm). Regardless of the actual exposure, it is important to pay attention to the patient's symptoms of pain and distress while attempting to discern actual exposure.

The US military has experienced several OMUS incidents. In World War I, outbreaks of gas neurosis (gas hysteria) occurred, in which some soldiers experienced symptoms of gas poisoning (eg, dyspnea, coughing, and burning of skin) without clinical exposure to gas.[35] In one incident, 500 battle-tested troops drifted into medical aid stations over a 1-week period following desultory gas shelling. They exhibited chest pain, fatigue, dyspnea, coughing, husky voice, and indefinite eye symptoms, all consistent with chemical exposure.[36] However, the divisional gas officer found no evidence of gas inhalation or burning.

More recently, in 1988, 1,800 male military recruits were evacuated from barracks due to an epidemic of coughing, dyspnea, and chest pain that broke out at a training center.[37] The symptoms were consistent with exposure to a chemical agent or toxin. Recruits and medical personnel suspected an airborne toxin, but none was detected. These examples of OMUS demonstrate that a perceived exposure can induce symptoms resembling an actual exposure.

The Goiânia radiation incident was a dramatic example of a co-occurrence of OMUS and a CBRNE event. Over 125,000 people demanded to be screened for radiological exposure following the news of radiological contamination.[38] Screening identified only 249 persons with any radiological contamination, but 5,000 of the first 60,000 people screened had symptoms consistent with radiation sickness (vomiting, diarrhea, and/or rashes around the face and neck). None of the symptomatic persons were contaminated.

Chemical Warfare Agents

The Israeli experience with 18 Scud missile attacks during the Persian Gulf War involved both the effects of missile explosions and, at least initially, the perception of a possible nerve agent attack. One study of patients arriving in the emergency departments of 11 local hospitals in Israel[19] found that approximately 332 of the 773 casualties (43%) were psychological casualties and an additional 209 (27%) had injected themselves with atropine because they feared the missiles contained nerve agent. After the first Scud attack, there were 365 casualties: 172 psychological casualties (47%), 171 cases of unjustified atropine injections (47%), and only 22 cases of physical injury (6%). Another study[20] looked at patients reporting to the emergency department of a Tel Aviv hospital within 8 hours of a Scud attack. Of the 103 patients admitted, 70 had psychological distress (68%) and 19 had unjustified atropine injections (18%); only 9 had direct injuries (9%). All these findings were among civilians, not soldiers.

After the 1995 sarin attack in the Tokyo subway,[33,39] over 5,500 people visited 280 medical facilities the day of the attack and the following week. Of these, 1,046 were admitted as patients. Saint Luke's International Hospital saw the most patients: 641 patients on the first day and 349 in the following week.[39] Of the 641 patients admitted to the emergency department on the first day, 111 were admitted to the hospital (4 severe cases, 107 moderate cases), and 530 mild cases were observed for 6 hours and then released. The patients with mild cases suffered mainly from eye problems. It is difficult to determine from the literature how many of the mild cases were psychological casualties.

Biological Agents

In 1994 two outbreaks of plague occurred in India: a bubonic plague outbreak in Maharashtra state, followed by a pneumonic plague outbreak 1 month later and 500 km away in Surat.[40] Of the 5,000 suspected cases of plague, there were 167 confirmed cases and 55 deaths.[41] Unfortunately, no data are readily available on psychological reactions or rates of such reactions. However, there were observable effects on behavior. The local media fueled the anxiety with exaggerated reports.[41,42] An estimated 400,000 to 600,000 people fled Surat, including hospital staff, private medical practitioners, and municipal workers.[43,44] In Delhi, 1,200 km from Surat, people fashioned masks from available materials, and many bought and hoarded tetracycline, an antibiotic used to treat plague.[45]

In 2001, after the September 11th attacks and before the first of 23 anthrax cases,[46] the media had already reported increased purchases of gas masks and ciprofloxacin ("cipro," used to treat anthrax). After the anthrax mail attacks, there were increased patient requests for ciprofloxacin and anecdotal reports of increased prescriptions.[47] Hospitals reported their already busy emergency rooms were filled with people anxious about anthrax, many demanding treatment.

The outbreak of SARS, a new and emerging infection, created much fear and anxiety. In Beijing, schools and universities were closed, hundreds of companies closed their doors, and some surrounding villages shut themselves off from contact with others.[48] Rumors of neighborhoods being quarantined led to stockpiling of food.[49] Although officials asked people to avoid travel, thousands of businesspersons, migrant workers, and college students left Beijing. In Taiwan, 160 doctors and nurses quit work at various hospitals, fearing both the disease itself and the inadequacy of infection control measures.[50] SARS patients often spent hours in isolation between contacts with staff and were deprived of family visits, leading to complaints of sadness, anxiety, boredom, loneliness, and nonspecific anger and frustration.[51,52] Fear and anxiety often waxed and waned with fever.[51]

One study measured the psychosocial effects of SARS on hospital staff in a Toronto hospital using questionnaires.[53] Almost two thirds of the respondents reported concerns for their own or their family's health. Factors associated with increased concerns were perception of a greater risk of death from SARS, living with children, personal or family lifestyle affected by SARS outbreak, and being treated differently by other people because of working in a hospital. Emotional distress was found in almost 30% of all responders and in 45% of nurses, who were most at risk for infection. Factors identified for significant association with emotional distress were being a nurse, part-time employment status, lifestyle affected by SARS outbreak, and ability to do one's job affected by precautionary measures.

Radiological Agents

The Three Mile Island (TMI) accident in Pennsylvania in 1979 demonstrated the importance of psychological effects following a CBRNE incident. According to the president's commission that studied the accident, the only medical effect documented was mental distress.[54] There were no cases of ARS, and the estimated exposure doses for people living within 10 miles of TMI were approximately the dose of an average chest radiograph, much lower than the annual background radiation dose.[55] Populations exhibiting the most distress were TMI workers, families with preschool-age children, and those living within 5 miles of TMI. Studies of TMI workers reported no long-term effects, only short-term acute effects. TMI personnel reported nausea, stomach troubles, headaches, diarrhea, sleep disturbances, and loss of appetite in greater frequency than did the control group. These symptoms are also common to the ARS prodrome, but TMI personnel were not exposed to radiation doses that would cause ARS.

Unlike the TMI accident, the 1986 Chernobyl accident in Ukraine did release significant amounts of radiation. Approximately 135,000 people were evacuated from a 30-km zone in the first 2 weeks after the accident. Most of these people had to be permanently relocated. In addition, an estimated 600,000 to 800,000 "liquidators" were brought in to handle the emergency situation and subsequent cleanup operations.[56] Although over 200 cases of ARS were recorded, the primary health effect was widespread psychological distress.[57,58]

In the 1987 Goiânia incident, two scavengers removed a cesium-137 teletherapy unit from an abandoned radiotherapy institute.[59] While dismantling the unit, they accidentally ruptured the source capsule that contained radioactive cesium-137 powder. When the accident became public, the perceived threat of radiation exposure caused over 120,000 people (approximately 10% of the city's population of 1.2 million) to be screened over a 6-month span for possible contamination.[60] Residents and others in the city at that time felt sufficiently at risk that they took time off from work or came on weekends to wait in line to be scanned.[38,61] Approximately 5,000 (8%) of the first 60,000 people screened presented with symptoms that mimicked ARS (eg, rash around neck and upper body, vomiting, diarrhea), but none of these individuals were contaminated.[38] Only 249 people had measurable radiological contamination.

Explosives

Acute psychological effects were reported in 50% of bomb-injured patients in one study.[62] Another study reported that approximately 12% of the casualties presented with emotional distress, with another 6% presenting with medical problems (eg, angina, diabetes, headache, or asthma).[63]

Mental Disorders

Chemical Warfare Agents

Most patients from the Tokyo sarin attack who were admitted to a hospital remained hospitalized for a few days. Some reported sleep disturbances, nightmares, and anxiety. Whether these symptoms were due to acute stress disorder or to exposure to nerve agent is unknown. In studies done 1 month after the event, nearly 60% of casualties reported suffering from postincident symptoms, including fear of using the subway, sleep disturbances, flashbacks, depression, nightmares, irritability, headaches, malaise, physical tension, and emotional lability and irritability.[33,39] Follow-up questionnaires at 3- and 6-month intervals showed little decrease in the percentage reporting symptoms. Unfortunately, it is difficult to determine to what extent these symptoms were psychological effects and to what extent they may have been sequelae to the cholinergic effects of sarin exposure. Because most of the casualties from Saint Luke's International Hospital were mild cases (suffering mainly eye symptoms), it is possible that many of the postincident symptoms were psychological.

Radiological Agents

Most of the 20 hospitalized Goiânia patients suffered from depression and anxiety.[64] The 11 victims most seriously affected were moved to one hospital, where they were kept confined and isolated because of immunosuppression, and the medical personnel treating them wore protective masks. Both measures increased stress in patients. Uncertainty about future health effects also increased stress, as did the lack of information concerning the duration of their treatment and the long-term prognosis.

Nuclear Weapons

Of all CBRNE agents, nuclear weapons have the greatest destructive impact—they are the quintessential weapons of mass destruction. The atomic weapons dropped on Hiroshima and Nagasaki caused incredible devastation, outbreaks of local fires, and large numbers of dead, dying, and injured people.[65] In interviews done after the war, approximately two thirds of survivors described psychological disturbances of intense fear, emotional upset, or depression. However, only a single incident of an apparent mass panic was reported at Hiroshima: a large group of frightened people in a park pressed some victims into a river, and several died.[66]

During the following weeks, survivors continued to witness the sight of severely injured people suffering from burns and blast injuries. In addition, there were outbreaks of ARS. The continued exposures to the devastation and human suffering served as a constant reminder to survivors and reinforced the psychological impact of the original event.[65]

LONG-TERM EFFECTS

Distress and Chronic Outbreaks of Multiple Unexplained Symptoms

Although acute OMUS has been widely studied, the possibility of long-duration and large-scale OMUS syndromes has only lately been suggested.[67] In recent years, a number of different chronic syndromes (eg, chronic fatigue syndrome, environmental somatization syndrome, multiple chemical sensitivity syndrome, and sick building syndrome) have appeared, all characterized by multiple nonspecific symptoms (eg, fatigue, headaches, sleep disturbances, nausea, dizziness, muscle and joint pains, and difficulties with memory and concentration) that are not connected with specific infectious or toxic agents.[68–70] In each of these syndromes, the patient attributes an invisible contaminant or infectious agent as the cause for the symptoms.

Military Experience

The military has seen several chronic OMUS syndromes, including Agent Orange syndrome, atomic veterans syndrome, and Gulf War syndrome.[3] Agent Orange syndrome began when the media publicized an association between exposure of Vietnam veterans to Agent Orange and a reported epidemic of cancer and children born with birth defects. Epidemiological studies done by the Centers for Disease Control and Prevention found no evidence of increased incidence of cancer or birth defects in this population.[71–73] However, an increased prevalence of depression, anxiety, alcohol abuse or dependence, and posttraumatic stress disorder (PTSD) was demonstrated in Vietnam veterans compared with subjects who had not fought in Vietnam.[71] Another study found that symptoms of psychological distress were strongly associated with self-reported herbicide exposure. This group presented with more symptoms than were found in Air Force personnel actively involved in aerial spraying of herbicides.[74] This suggests that Agent Orange syndrome might be more related to a perception of exposure than to actual exposure.

An estimated 200,000 Department of Defense personnel (both military and civilian) observed the early US above-ground nuclear tests.[75] The external doses received by these "atomic veterans" averaged about 0.5 rem, with many receiving no dose and only 1% receiving a dose greater than 5 rem (the maximum annual occupational dose). Several case studies of atomic veterans reported long-term psychological distress.[76,77] Initially, troops at the Desert Rock V test seemed to go through the experience with equanimity,[78] but many years later, an anecdotal study found that veterans reported vivid recollections of an atmosphere of tension and fear at the test sites and thought they had been ill-prepared.[76]

A cluster of functional somatic symptoms was reported in atomic veterans and dubbed the "radiation response syndrome."[77] The syndrome has two components: (1) a core belief that radiation had caused physical harm, and (2) functional somatic symptoms that appeared to be an expression of this belief. The radiation response syndrome belief system included the views "that men were dying, that doctors are of little help, that one doctor may exist who could help, that the government is to blame for their illness, and that people think they are crazy for blaming exposure to ionizing radiation for their illnesses."[77(p128)] Radiation response syndrome resembles delayed-onset PTSD, but rather than reexperiencing the trauma as in PTSD, the veterans are preoccupied with radiation and its effect on their lives.

Chemical Warfare Agents

Three years after World War I, approximately one half of gassed veterans claimed subjective complaints in medical examinations.[79] When there were no objective findings, no compensation or pensions were paid, nor were these complaints included in statistics of permanent disabilities. There were reports of large numbers of men who had recovered from acute gas poisoning and had good physical examinations, but suffered from serious sequelae, most particularly of easy fatigability and difficulty breathing on exertion.[80] This condition was variously known as effort syndrome, disordered action of the heart, and neurocirculatory asthenia. Chronic gas cases often involved acute attacks of breathlessness at night accompanied by nightmares, and patients usually reported insomnia and unrefreshing sleep.[80]

A long-term study of sarin patients who had been hospitalized at Saint Luke's Hospital found that somatic and psychological symptoms continued for 5 years after the incident.[81] A high rate of medically unexplained physical symptoms was reported. Eye symptoms, fatigue, muscle stiffness, and headache were all reported by more than 10% of the study population.

Biological Agents

Puzzling long-term effects were seen in the survivors of the 2001 anthrax attacks. Newspapers reported that survivors continued to exhibit symptoms of fatigue, shortness of breath, chest pains, memory problems, nightmares, and rage 6 to 12 months after their illnesses.[82] Only one of the inhalational anthrax survivors was well enough to return to work at the time of the study. In the one published study of anthrax survivors 1 year after the attack, many of the survivors reported reduced health-related quality of life and psychological distress.[83]

Radiological Agents

No long-term psychological stress in TMI workers has been reported.[84] However, TMI residents, compared to controls, displayed a significant amount of stress on several measures (performance; self-reported measures of anxiety, depression, and somatic complaints; physiological measures of urinary norepinephrine, epinephrine, and cortisol; disturbed sleep; and changes in immune system parameters) for up to 6 years after the accident.[85–87] The TMI symptoms were not the result of exposure to radiation but to perceived radiation threat, demonstrating that fear of exposure to radiation can cause significant distress and stress symptoms that can mimic symptoms of actual radiation exposure.

The large number of people (~10,000) who lived or worked within 300 meters of the contaminated area in Goiânia exhibited fear, psychosomatic reactions, fear about the future, insecurity, and doubt about the effectiveness of government remedial measures.[88] A public opinion poll conducted 6 months after the incident[88] found that two thirds of both affected Goiânia residents and a control group living away from the contamination believed that Goiânia was still contaminated. Research conducted 3 years later showed that stress parameters were still increased and performance decreased both in nonirradiated individuals with perceived exposure (those living within 1 km of the area where contaminated waste from the incident had been stored) and in irradiated individuals from Goiânia.[89]

A variety of psychoneurological syndromes have been reported as sequelae of Chernobyl in the Russian literature.[90–92] These syndromes are characterized by multiple unexplained physical symptoms including fatigue, sleep and mood disturbances, headaches, impaired memory and concentration, and muscle or joint pain. These syndromes were reported in liquidators who both had and had not experienced ARS.[90,92] No significant correlations were found among physical symptoms, radiation dose, and physical examination data.[92]

Nuclear Weapons

Survivors of Hiroshima and Nagasaki were severely stigmatized, especially those with severe burns that resulted in scarring and keloids. Lifton described a "neurasthenic survivor syndrome" characterized by "persistence of symptoms of withdrawal from social life, insomnia, nightmares, chronic depressive and anxiety reactions and far-reaching somatization . . . in addition, fatigue, emotional lability, loss of initiative, and generalized personal, sexual and social maladaptation."[93(p504)] A study of over 7,000 Nagasaki atomic bomb patients done 15 years later showed long-term psychological effects in approximately 7%, with the majority complaining of fatigue, lack of spirit, poor memory, and introversion.[94] These symptoms were twice as common in survivors who had shown ARS symptoms and were related to severity of ARS symptoms.

Mental Disorders

Chemical Warfare Agents

PTSD has been reported in American World War II veterans exposed to mustard agent while participating in field trials and chamber tests.[95] According to follow-up studies of the Tokyo sarin attack, conducted 3 and 5 years after the accident by the National Police Agency and the National Research Institute for Police Science, reporting of somatic complaints—eye strain, weakened eye sight, and easy fatigability—remained relatively stable from the acute stage through both follow-up periods.[33] PTSD symptoms still reported by 14% to 18% of studied survivors included flashbacks, fear of the subway, intense distress at exposure to reminders of the attack, and avoidance of thinking about the attack.

The casualties seen at Saint Luke's were surveyed at 2, 3, and 5 years, using a questionnaire that asked about 14 physical symptoms, 8 eye symptoms, and 11 psychological symptoms (symptoms of avoidance, hyperarousal, and reexperiencing).[81] The most common symptoms across all time periods were eye symptoms: eye strain (33%–39%), dim vision (23%–26%), and difficulties focusing (17%–21%). Physical symptoms (tiredness, fatigue, muscle ache, headache) were also common. Most of the psychological symptoms remained stable over the three time periods, with rates of 10% to 16% still being reported at the 5-year point for memory difficulties, depressed mood, avoidance of accident reminders, flashbacks, and fear in the subway or at the attack site. PTSD frequency, as determined by criteria in the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition*,[96] remained stable, with 2% to 3% of patients meeting the criteria during the three time points. The incidence of partial PTSD (one symptom from each category) ranged from 7% to 9%. Because of the persistence of physical symptoms, a modified set of PTSD criteria (adding at least one medically unexplained physical symptom to the diagnosis) were developed, and 10% to 14% of patients met these criteria. The physical symptoms were reported to deteriorate following flashbacks and to improve during psychiatric therapy. The victims continued to be stressed by lack of government support, limited resources available for medical follow-ups, and a feeling of stigmatization.

Biological Agents

Several infectious disease outbreaks have been reported to cause both PTSD and a decreased health-related quality of life. For example, the majority of survivors of an outbreak of Legionnaires disease reported fatigue, neurologic symptoms, and neuromuscular symptoms 17 months after diagnosis.[97] Health-related quality of life was impaired in seven of eight dimensions, and 15% of patients experienced PTSD. Similarly, survivors of acute respiratory distress syndrome have also reported PTSD and decreased health-related quality of life.[98,99] Because most category A biological warfare agents cause acute respiratory distress syndrome, similar long-term effects should be expected.

Radiological Agents

A study conducted 8 years after the Chernobyl accident found that 44% of 1,412 Latvian liquidators had mental-psychosomatic disorders: depression (neurotic depression and brief depressive reaction), physiologic malfunction arising from mental factors, or unspecified disorders of the autonomic nervous system.[100] The actual numbers of mental-psychosomatic disorders might have been higher, but anxiety, PTSD, and sleep disturbances were not studied because of the coding scheme used.[101] Two other studies of Chernobyl exposure found PTSD and PTSD symptoms.[102,103]

An epidemiologic study of over 4,700 Estonian liquidators found an increase in suicide, but no increases in cancer, leukemia, or overall mortality.[104] Suicide accounted for almost 20% of mortality in the liquidator cohort. Reasons for the increased suicide rate are not currently known. However, data from Vietnam veterans with PTSD have demonstrated an increased risk for traumatic deaths, including suicide.[105] Other studies demonstrating a variety of mental health disorders in Chernobyl liquidators support the speculation that fear of radiation might cause depression, PTSD, and other disorders associated with increased rates of suicide. The primary toxic agent appears to be fear, rather than radiation.

Explosives

Long-term psychological consequences after terrorist attacks with explosives have been reported. After the Oklahoma City bombing, 45% of the survivors suffered a postdisaster psychiatric disorder, including 34% with PTSD.[106] Another study reported PTSD in 50% of the patients 6 months after a bombing.[107] PTSD patients had a lower mean injury severity score (1.2) than did patients without PTSD (6.6). Nearly one in five civilian survivors of terrorist attacks (18%) in another study suffered from PTSD, while another 13% suffered from major depression.[108] When broken down by severity of injury, PTSD was present in 31% of the severely injured, but in only 11% of the uninjured and 8% of the moderately injured. The adjusted prevalence ratio for PTSD (severely injured / others) was 4.2. Similarly, major depression occurred in 22% of the severely injured, but in only 9% of the moderately injured or uninjured.[108]

SUMMARY

Mass panic is not likely to occur in CBRNE incidents. Although mass panic can occur in situations involving limited escape routes, it will still probably be a rare event. Psychological effects are likely to cause large numbers of casualties following attacks using CBRNE weapons. Initial presentation may resemble combat stress casualties or may include a variety of nonspecific symptoms, such as difficulty breathing, dizziness, fatigue, headache, and sleep disturbances. Triage and differential diagnosis may be challenging in the initial stages. The number of psychological casualties could increase based on possible amplification of risk perception by mass media reporting. Unlike most physical injuries or illnesses caused by CBRNE agents, psychological effects can be contagious. Given the history of postcombat syndromes, long-term effects are also very likely, and will be difficult to diagnose and treat. These chronic OMUS syndromes will also be greatly influenced by risk perception and mass media reporting.

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