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# Mass Gatherings

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## DESCRIPTION OF EVENT

Thousands of mass gathering events take place worldwide each year. In the United States, as many as 65 million attend National Basketball Association (NBA), National Football League (NFL), and/or National Collegiate Athletic Association (NCAA) events. The inauguration of President Obama on January 20, 2009, attracted a crowd of 1.8 million to the National Mall in Washington, D.C.; a state of emergency was declared to allow the release of federal money and resources. Protests during the Arab Spring in 2011 drew millions of largely peaceful protesters to central locations of Tunis, Tunisia, and Cairo, Egypt. More than 5 million were present when the departure of Egypt's President Hosni Mubarak was announced in February, 2011.<sup>1</sup> Millions of people celebrated the 2014 World Cup in Brazil without significant problems; it seems that lessons have been learned from previous soccer disasters (Table 202-1).

There is no consensus on a definition of a “mass gathering.” The World Health Organization (WHO) defines it as “an organized or unplanned event where the number of people attending is sufficient to strain the planning and response resources of the community, state, or nation hosting the event.”<sup>2</sup> The National Association of Emergency Medical Services Physicians (NAEMSP) defines it as “organized emergency health services provided for spectators and participants at events in which at least 1000 persons are gathered at a specific location for a defined period of time.”<sup>3</sup>

There are two types of mass gatherings: the *traditional*, such as religious festivals, sporting events, music concerts, fairs, and parades; and the *nontraditional*, which have not been researched very well, including metropolitan subway systems, large shopping complexes, airports, cruise ships, public demonstrations, and refugee camps.<sup>4</sup> Medical care of some sort has been provided at such gatherings for the last 30 years in both the United States and Europe. Event organizers everywhere need to take responsibility for the safety and well-being of the participants at an event.

Considerable variation exists in the type of medical care provided to both participants and spectators at these gatherings. General standards have been proposed for the provision of primary care, emergency and disaster care, and means of evacuation. Both the American College of Emergency Physicians (ACEP)<sup>5</sup> and NAEMSP<sup>6</sup> have addressed the previous lack of guidelines and standardized care. A survey in 1998<sup>7</sup> showed that only six U.S. states provided regulatory guidance for the provision of care at mass gatherings, although many are now starting to address this omission.

Terrorist threats have become an unfortunate reality, as shown by the bombing at Centennial Park during the 1996 Olympics in Atlanta, Georgia, and the targeting of nontraditional mass gatherings, such as the Madrid train bombings in 2004, the Kenyan shopping mall mass

shootings in 2013, and the Boston Marathon Bombing that same year. Such events pose unique issues regarding the care and evacuation of patients, particularly in unsafe or unsecure scenes.

## PRE-INCIDENT ACTIONS

### Mass Gatherings Overall

At organized mass gatherings, predictable medical problems and an unpredictable wide variation in medical care exist worldwide. Preplanning and prediction of resource requirements, based on careful needs assessment of anticipated medical care usage and public health risks, may lead to a standardized optimal provision of medical care (Box 202-1).<sup>8</sup>

Provision of medical care is the responsibility of the event planners. Public health officials need to be involved early in the planning process, especially for large events, such as the Olympics, world fairs, and pilgrimages. The local health department should be involved in overseeing the preparation, storage, and serving of food and sanitation requirements. Once identified, those providing medical care at mass gatherings need to liaise with local emergency medical services (EMS), fire, and law enforcement officials. Ground and building plans, close estimates of possible attendance, and identification of any specific hazards should be shared among these providers. Multiple variables interact to make planning for a mass gathering event challenging. An understanding of these may allow for a more efficient and effective planning process. Some of these variables will be discussed below.

### Security and Crowd Control

Estimates of attendance may be gleaned from advanced ticket sales or from attendance at previous similar events. However, previous history is notoriously unreliable, as demonstrated by the papal mass in Denver (1993) where 250,000 people were predicted but 500,000 turned up. An adequate ticketing system is essential, as well as public address measures to inform crowds of no further access to an event once capacity is reached.<sup>9</sup>

Mass gathering venues should have multiple access points for entering and exiting the site. During the 1990 Hajj, 1426 people lost their lives due to a stampede as all the pilgrims were trying to leave the city of Mecca at the same time through a tunnel.<sup>10</sup> Planners should promote a unidirectional flow of the crowd, which would significantly reduce the risk of crowd convergence. Training of security staff in crowd control should be implemented before an event to improve crowd safety and avoid panic should overcrowding occur. During a football match in Ellis Park, South Africa, tear gas was thrown into a crowd by event security in an effort to disperse intense overcrowding. This, unfortunately, served to incite panic and caused a stampede (Table 202-1).<sup>9</sup> Keeping the crowd comfortable and relaxed is also essential, therefore awnings,

TABLE 202-1 Major Soccer Disasters

YEAR	MONTH, DAY	DISASTER
1985	May 11	<i>Bradford, England:</i> 56 burned to death, 200 injured due to a fire at Bradford soccer stadium.
1985	May 26	<i>Mexico City:</i> 10 trampled to death and 29 injured forcing their way into a match.
1985	May 29	<i>Brussels, Belgium:</i> British soccer fans attack rival Italian supporters at Heysel Stadium. A concrete retaining wall collapses, resulting in 39 deaths and more than 400 injured.
1988	March 12	<i>Kathmandu, Nepal:</i> 80 fans seeking shelter during a violent hailstorm are trampled to death.
1989	April 15	<i>Sheffield, England:</i> 96 died at Hillsborough Stadium. Many were crushed to death when a barrier collapsed on an overcrowded area.
1992	May 5	<i>Bastia, Corsica:</i> 17 killed when a grandstand collapsed.
1996	October 16	<i>Guatemala City:</i> 84 killed and 147 injured by stampeding fans at Mateo Flores National Stadium.
2001	April 11	<i>Johannesburg, South Africa:</i> 43 dead, 250 injured at Ellis Park Stadium due to crushing as crowds pushed into an already overcrowded stadium.
2001	May 9	<i>Accra, Ghana:</i> More than 120 killed in a stampede at a soccer match.
2004	March 12	<i>Damascus, Syria:</i> A riot erupted at a soccer match, killing more than 25.
2007	Nov 25	<i>Salvador, Brazil:</i> 7 died and about 40 were injured when a stand collapsed.
2012	Feb 1	<i>Port Said Stadium, Egypt:</i> 79 killed and more than 1000 injured as a result of riots.

### BOX 202-1 Requirements for Medical Care at Mass Gatherings

- Medical oversight by a physician
- Medical reconnaissance
- Medical equipment
- Negotiations for event medical services
- Human resources
- Level of care
- Treatment facilities
- Transportation resources
- Communication
- Public health elements
- Access to care
- Emergency medical operations
- Command and control
- Documentation
- Continuous quality improvement (CQI)

Adapted from data from NAEMSP.

cooling fans (in hot weather), and entertainment are sometimes helpful and should be part of the preplanning.

### On-Site Medical Care

It is crucial to establish goals for medical services. These include the following:

- Establishing rapid access to injured or ill patients and providing triage
- Stabilizing and transporting seriously injured or acutely ill patients in a timely manner
- Providing on-site care for injured or ill patients<sup>4</sup>

The type of medical care to be provided at the event needs to be considered beforehand (Table 202-2).<sup>11-15</sup> Primary medical care, such as first aid, emergency care, and preparation for a possible disaster, should be addressed. Staffing levels and type of staffing also need to be anticipated. Recommended ratios include one to two physicians per 50,000 attendees, two paramedics or one paramedic and one emergency medical technician per 10,000 attendees, and one basic first aid provider per 1000 participants at the event.<sup>16</sup> On-site physicians have been shown to reduce ambulance transfers to local hospitals by as much as 89%,<sup>17</sup>

TABLE 202-2 Anticipating Medical Needs at Mass Gatherings Based on Type of Event

TYPE OF EVENT	INJURIES TO BE EXPECTED
Political events	Minor and major trauma
Religious events	Minor injuries, heat-related problems, cardiac problems
Musical events	Drug or alcohol use, minor trauma
Sporting events	Minor trauma, heat-related problems, and cardiac issues
Auto racing	Severe trauma, heat- and alcohol-related problems

significantly lessening the impact of an event on local EMS services and hospitals. The majority of nondisaster injuries and medical complaints at a mass gathering can be effectively treated at the scene, which reduces the number of hospital referrals and patient presentation rates to the hospital. Physician presence should be strongly encouraged at events where significant trauma may occur or where there is a long distance to definitive care. Cardiac arrest cases are rare in mass gatherings, with reports of 0.5 to 1 per 500,000, though on-site resuscitation and early defibrillation are important and can improve patient survival rates.<sup>18</sup>

A prediction tool for expected medical needs considering five different variables (attendance, heat index, crowd age, crowd mood, and availability of alcohol) was developed and tested in 55 mass gathering events (Tables 202-3 and 202-4).<sup>19</sup> After the anticipated usage rates and staffing levels have been addressed, the positioning, number, and type of aid stations should be considered. Fixed events at stadiums may have areas specially designed and designated for medical care. For other events, aid station locations should be no more than a 5-minute walk for attendees. Stations should be clearly visible, and the locations should be known to participants and other event personnel. These areas need to be adequately and appropriately staffed before the anticipated start of the event, and remain so until the event is completed. Consideration needs to be given to providing medical care in the crowd for occurrences such as cardiac arrest or lower extremity fractures, including how to transport these patients to aid stations. Thought needs to be given regarding provision of ambulances for hospital transport and access and egress for these vehicles. The organizers of medical care need to know the capabilities of local hospitals and should liaise with hospital personnel before the event. All patient encounters should be

**TABLE 202-3 Prediction of Patient Presentation Rates at Mass Gathering Events**

ATTENDANCE	WEATHER (HEAT INDEX)	CROWD AGE	CROWD MOOD	AVAILABILITY OF ALCOHOL	POINT VALUE
>15,000	>90 °F (>32.2 °C)	Older	Animated	Significant	2
1000-15,000	<90 °F (<32.2 °C)	Mixed	Intermediate	Limited	1
<1000	Climate not controlled Climate controlled	Supervised younger	Calm	None	0



**TABLE 202-4 Recommendations for Medical Need**

EVENT CLASSIFICATION	RECOMMENDATIONS
Major (total score >5 or scores of 2 in two different categories)	Multiple ALS personnel, specialized equipment, physicians
Intermediate (total score >3 but <5 or score of 2 in any one category)	Two transport units with 1-3 ALS and 1-6 BLS providers
Minor (total score <3)	Single transport vehicle with 1 ALS and 1 BLS provider

ALS, advanced life support; BLS, basic life support. Modified from reference 19.

documented. Use of noncarbon record (NCR) paper will facilitate a copy accompanying a patient who needs transport to a medical facility. Records are needed for medical and legal reasons and may also be useful for research purposes.

**Environmental Factors**

There is a positive correlation between temperature and humidity and patient presentation rates.<sup>20</sup> Heat indexes, which take into account the temperature and the humidity, are probably a better indicator of medical need, as it has been shown that with every 10° rise in the heat index, the number of patients per 10,000 spectators (PPTT) tripled.<sup>21</sup> Thirty-one percent of physician encounters at the 1996 California AIDS ride were for heat-related problems.<sup>22</sup> The Denver papal visit resulted in an unanticipated 21,000 patient encounters at a mainly youthful gathering, due in part to the 14-mile walk and high temperatures.<sup>23</sup> Preplanning for the Atlanta Olympics in 1996, in the form of education about preventing heat-related illnesses given to those who purchased advance tickets, might have led to a decrease in the number of patient encounters, despite the high heat and humidity.<sup>24</sup> Cold weather events generally lead to lower medical usage rates by participants and spectators.<sup>25</sup> Use of weather surveillance, early warning systems, and evacuation to shelter protocols is important in cases of storms and lightning.

**Alcohol and Illicit Drug Usage**

An increase in the number of patient medical encounters may be related to alcohol and illicit drug usage. Historically the consumption rate of alcohol and drugs may be higher at music festivals, rock concerts, and raves. Open-air music events in the United Kingdom have resulted in a primary diagnosis of alcohol intoxication in 4% of patient encounters.<sup>26</sup> Banning the consumption of alcohol at Wembley Stadium led to a 50% reduction in alcohol-related problems.

**Crowd Density and Demographics**

An increase in crowd size does not necessarily mean an increase in medical usage. One study has shown that the overall medical usage rate decreases with overall crowd size. Patient encounters at events with

more than 1 million participants average 10 per 10,000 participants. Events with fewer participants average 41 per 10,000 spectators. One interpretation of this is that it is easier to seek medical care at a less crowded venue. The medical usage rate can vary even within an event itself. At the Los Angeles Olympics, soccer events had usage rates of 68 per 1000, and rowing and canoeing, 6.8 per 1000 spectators.

Anticipated crowd demographics may be useful in the preplanning stage. Older groups may be expected at papal visits, classical music concerts, and large sporting events.<sup>27</sup> Younger groups frequently attend rock concerts and auto-racing events.<sup>28</sup> The needs of children also must be considered. Most children present with minor injuries, but medical teams need to be prepared to deal with serious medical emergencies and trauma. Overall medical usage at a children’s fair was 19.2 per 10,000 participants, and half of those who presented were younger than 14 years old. Protocols need to be in place for the provision of care to minors who present without an accompanying adult.<sup>14</sup>

**Event Type**

Event type is an unpredictable variable. Certain types of music, known team rivalries, and religious furor may lead to disruptive behavior and an increase in medical usage rates. Crowded events may lead to a “too-close-for-comfort” feel among attendees. Environmental conditions, such as inclement weather, squalid conditions, poor sanitation, and lack of access to drinking water, may lead to ugly crowd dynamics.

Despite the many variables to be considered, it has been shown that event type and temperatures are the ones that best predict medical usage rates.<sup>12</sup> Examples of event types will be discussed later in this chapter. Other variables to consider include event duration and time of occurrence.

**Command Structure and Communication**

Attention to the location, staffing, and communication needs of a medical command center should be addressed. Communication needs should be considered for event medical providers, other event planners, and local EMS, police, and fire personnel. Backup communication in the form of handheld devices or cell phones should be decided on, and medical personnel must be able to connect with local dispatch centers.

An incident command structure for medical personnel may be used. The event medical officer oversees all aspects of medical care provided at the site. The event triage officer conducts and directs medical assessment of casualties at designated treatment areas or while roving through the crowds and transporting patients to a central area. The event treatment officer oversees treatment to the sick and injured. The event transport officer directs transport to other facilities, and the logistics officer provides the necessary support for EMS at the event. Consideration may be given to the need for hazardous material teams, decontamination, wilderness medicine, or use of amateur radio groups.

The NAEMSP addressed 15 components on which event planners must focus (Box 202-1). For a detailed review of these elements, the NAEMSP produced a comprehensive document entitled “Mass Gathering—Medical Care; The Medical Director’s Checklist.”<sup>28</sup>

## Concerts and Sports Gatherings

The medical usage rate may vary by type of music, with rhythm and blues having rates of 1.3 per 10,000 and gospel or Christian 12.6 per 10,000 attendees. The overall median usage for concerts is 2.1 per 10,000 attendees.<sup>27</sup> Rock concerts typically have rates 2.5 times that of other concerts. The anticipated audience participation in “moshing,” crowd surfing, and stage diving may lead to a dramatic increase in medical incidents.<sup>29</sup> Other problems encountered include minor trauma and alcohol or illicit drug intoxication.<sup>30</sup>

Surgical problems may be caused by falls, assaults, being crushed against barriers, and assorted “missiles” causing head injuries. Severe trauma may occur in up to 1.4% of attendees at rock concerts. Medical issues include headache, syncope, asthma, and hypoglycemia. Cardiac arrest is uncommon, with a rate of 0.01 to 0.04 per 10,000 attendees. Asthma may be very common at rodeos.<sup>31</sup>

The ultimate sporting event is probably the Olympics. Planning for the medical care of both spectators and participants begins as soon as the host city has been announced. Around 10 million spectators attended the 2012 London Olympics. Apart from routine medical care, there exists a potential for transmission of infectious diseases, risk of injury from crowd crushing, and now the very real risk of terrorist activity or political protests. Extensive planning at local, state, and federal levels is vital to ensure the health and safety of all concerned.<sup>32–34</sup>

At the 1996 Atlanta games, specialized incident assessment teams were set up to analyze terrorist risks and to address issues such as stockpiling of antibiotics and antidotes. Medical providers of all levels received training in awareness of chemical, biological, and radiological weapons.<sup>35</sup> Local hospitals were updated to include mass decontamination units. Local EMS providers were given uniform operational plans and procedures, enhanced communications were agreed on, protocols were developed for the management of heat-related illnesses, and guidelines for response to mass casualties were issued. Public health initiatives to address heat-related illnesses included a media campaign; packets sent to ticket purchasers; shelters; and provision of water, wide-brimmed hats, sunscreen, and water misters at the most crowded sites. These, plus the cooler-than-normal temperatures, may have led to a decrease in the expected number of hyperthermia victims. Organizers of the 2010 World Cup in South Africa developed an infectious disease surveillance system for the event, which reported to a national health operations center. Despite taking place over a month during the peak of the influenza season in South Africa (in anticipation of which WHO donated 3.5 million doses of pandemic H1N1 vaccine), only 30 communicable disease events were reported.<sup>36</sup>

## Marathons

More than 300 marathons are staged each year, along with countless half marathons, triathlons, and 5K and 10K events. Pre-Event considerations include course layout, number of runners, climate, and medical team experience. Earlier start times and the addition of half marathons have led to a decreased risk of injury.<sup>37,38</sup> Encouraging runners to seek help early has also reduced serious medical problems.<sup>39</sup> Educating runners before the event on issues such as dehydration, hypoglycemia, exhaustion, blisters, the importance of good preparation and training, and the use of energy drinks may lessen the need for medical intervention. Runners with a history of asthma are encouraged to carry their inhalers and not to run if they feel ill. Accessible, visible first aid stations along the route, use of mobile paramedic teams, and a medical control center should provide adequate medical coverage. Radio communication is essential between medical providers, and a treatment tent at the finish line should

include paramedic and triage teams, massage therapists, and podiatrists. The use of computer tracking chips may be used to identify how many runners use medical treatment and help in the planning of the provision of care and supplies in the future.

On April 15, 2013, while thousands of spectators were celebrating the Boston Marathon, two pressure cooker bombs exploded, killing three people and injuring an estimated 264 others. The bombs exploded about 13 seconds and 190 m (210 yards) apart, near the finish line. Many of the victims suffered serious injuries, and at least 16 people lost limbs as a result of the blast and its debris. Many lives were saved that day because of good planning. The perfectly located medical treatment areas were well staffed and were immediately converted into a mass casualty triage unit, serving as a direct egress point for the ambulances. Only lifesaving procedures were done, without delaying the transfer of the seriously injured patients to hospitals. Victims were distributed equally to six Level 1 trauma centers surrounding the area, which avoided overwhelming a single center. Pre-Event coordination and planning among all agencies and hospitals, along with regular joined training and drills, were huge factors in the success of patient care.

## Pilgrimages

Millions of people perform pilgrimages every year. The Muslim pilgrimage, the Hajj, to the Holy Land of Makkah (Mecca) in Saudi Arabia, may have up to 2.5 million participants from 160 countries for a period of 5 to 7 days. The pilgrimage involves a 24-mile round trip from Makkah through the plains of Arafat. Many of the pilgrims are elderly, come from poor countries, live in tents in extreme conditions, and perform physically exhausting religious rituals. The Hajj season varies every year because it follows the lunar Islamic calendar. Therefore likely diseases also vary, depending on the temperature, which is a huge challenge for those involved in planning. In India, millions of pilgrims visit Lord Ayyappa at Sabarimala each year. This occurs over a 41-day period and involves a 90-minute trek uphill to the temple.

Kumbh Mela is a mass Hindu pilgrimage of faith in which people gather to bathe in sacred rivers. It is considered the largest peaceful gathering in the world; more than 100 million people visited during the Maha Kumbh Mela in 2013, a 55-day event. Thirty-six people died in a stampede at the Allahabad Railway Station the same year. A massive rush of passengers, returning from a dip in the waters of the Ganga and Yamuna rivers at the Maha Kumbh, contributed to the tragic event. Many other pilgrimages on a smaller scale take place throughout the world.

Several of the problems encountered may be anticipated. Many of the participants are not in good health and may have chronic medical problems. Heat exhaustion is common during the hot cycle of the Hajj. Cases of heat stroke doubled from 1980 to 1981. This could be overcome by educating pilgrims before and during the event. Infectious disease outbreaks are also common. These include meningococcal meningitis; gastroenteritis; hepatitis A, B, and C; and various zoonotic diseases. The implementation of vaccination policies, infection control policies, and public health initiatives have proven successful in addressing these problems.<sup>40</sup> Pilgrims need proof of appropriate vaccinations to obtain a visa for travel to Saudi Arabia. Face mask use is encouraged to reduce the spread of respiratory infections. Some of the mitigation actions taken at the Hajj are discussed in [Table 202-5](#). The 2014 Hajj faced particular infectious threats with both Middle East Respiratory Syndrome (MERS) and Ebola virus outbreaks in nearby regions.

Free medical care is provided at the holy site in Makkah. In 1997 and 1998 a “treat and release” program commenced, leading to a 73% reduction in ambulance transports.<sup>41</sup> In India at Sabarimala, a medical center is provided at the site. Typically 8000 pilgrims receive medical care over the 41-day period.

TABLE 202-5 Hajj Mitigation Actions

TYPE	INCIDENT	EXAMPLES OF MITIGATION ACTIONS	RESULTS
Communicable diseases	Meningitis outbreak (1987)	<ul style="list-style-type: none"> <li>Bivalent A and C meningococcal vaccines required for attending the Hajj</li> </ul>	No further outbreaks to serogroup A
	Hepatitis B and C outbreaks due to head shaving by unlicensed barbers (shaving is part of Hajj completion rituals)	<ul style="list-style-type: none"> <li>Full hepatitis B vaccine encouraged for all pilgrims</li> </ul>	No published results
	Cholera outbreak (1989), 109 pilgrims affected	<ul style="list-style-type: none"> <li>Only licensed barbers with strict hygiene measures are allowed to shave pilgrims</li> <li>Improvement in water supply and sewage treatment</li> </ul>	No further outbreaks reported
	H1N1 pandemic (2009)	<ul style="list-style-type: none"> <li>Strict regulation of food importation by pilgrims</li> <li>Discouraged pilgrims with high risk from participating in Hajj</li> <li>Thermography screening for febrile pilgrims at the airport</li> <li>Encouraged H1N1 vaccines</li> <li>Public health campaign (masks and hand hygiene)</li> </ul>	Limited documentation of H1N1 cases in 2009 Hajj season
Non-communicable hazards	Stampede: 1990 (1426 deaths) 1994 (270 deaths) 2006 (350 deaths)	<ul style="list-style-type: none"> <li>Construction of Jamarat Bridge reduced crowding from 10 people per m<sup>2</sup> to fewer than 4</li> <li>Unidirectional flow of pilgrims</li> <li>Antipanic systems and automated human stream networking</li> </ul>	No major events after 2006
	Fire in Mina: 1995 (150 deaths) 1997 (350 deaths)	<ul style="list-style-type: none"> <li>Fiberglass tents</li> <li>Use of electrical stoves instead of cooking gas</li> </ul>	Only limited cases

## ▶ POST-INCIDENT ACTIONS

In the wake of various disasters at mass gatherings, it is vital to learn from previous mistakes. The European Convention on Spectator Violence and Misbehavior met in 1985 to address issues rising largely from the Heysel Stadium Disaster. It identified the need for police and sports authorities to cooperate in ensuring segregation of rival supporters, controlling access to stadiums, and banning the consumption of alcohol. After the 1989 Hillsborough disaster in England, the Gibson Report recommended medical care at stadiums for the first time. All-seat stadiums were to be phased in, leading to safer stadiums with greater attendance. The Boston Marathon has instituted a post-event clinic that is open for 3 days after the event to meet the delayed medical needs of runners.

## ✚ MEDICAL TREATMENT OF CASUALTIES

The need for a mass gathering triage system is clear, because these events, by their very nature, have the potential to turn into mass casualty incidents (MCIs). Also, the current prehospital disaster triage systems are biased toward traumatic victims without considering medical complaints, drugs and alcohol, and environmental exposures, making these systems imperfect instruments for use in mass gatherings. Having a unified triage system that is agreed upon among all local agencies and hospitals is essential. Frequent training on triage is important for the success of any response plan.

In general, most participants require minor medical interventions that may be addressed by trained first responders or paramedics.<sup>11</sup> Paramedics may use triage protocols to identify casualties who should

be transported to a hospital after initial stabilization rather than waiting for treatment by an on-site physician.<sup>42</sup>

At rock concerts, 1.4% of attendees may experience severe trauma. Major and minor trauma results from falls, assaults, being crushed against barriers, and head injuries from assorted "missiles." Anticipated medical problems include headaches, syncope, hyperventilation, asthma, epilepsy, and hypoglycemia. At the Atlanta Olympics, most of the injuries were sprains or strains (13%) and contusion abrasions (7%); bronchitis was common (9%), and heat cramps and dehydration accounted for 7% of those seeking medical care.<sup>33</sup> In addition, three cardiac arrests were reported; the provision of defibrillators at mass gatherings is an important consideration.<sup>43</sup>

Hyponatremia is increasingly prevalent among marathon runners. It is defined as a serum sodium level of less than 136 mmol/L and is commonly caused by overhydration. Mild cases may be treated by fluid restriction and consumption of salty foods until urination resumes. In moderate cases the patient's sodium level may need to be checked hourly and, in critical cases, intravenous access will be required and diuretics and hypertonic saline may be administered. Complications such as seizures, pulmonary edema, and coma should be treated appropriately. Runners should be encouraged to replace only 16 ounces of fluid along with salt for every pound of weight lost. Exercise-associated collapse may occur at the finish due to venous pooling. This may be treated by laying the patient supine with the legs elevated and rehydrating with oral electrolyte or carbohydrate solution. Dehydration should be assessed clinically and treated with oral fluids. Heat-related illnesses are addressed in the usual fashion. Hypoglycemia is treated with oral or intravenous glucose replacement.

Many pilgrims are in poor health before the event and may need more than minor first aid. Many suffer from heat-related illnesses or infectious diseases. Provision of free medical care and on-site medical facilities with capabilities of providing even an intensive care unit level of care may meet these needs.

Disasters do occur at mass gatherings, and appropriate medical care needs to be available. Frequently, the cause of death is traumatic asphyxia,<sup>44</sup> for which rapid interventions may make a difference.

## UNIQUE CONSIDERATIONS

Every mass gathering should be considered as a unique event. Careful and exhaustive preplanning may reap many benefits. It is important for those providing medical care at the event not to do so in a vacuum. Local EMS providers may well be needed and certainly will be required if a mass casualty event occurs. Mass gatherings occurring in urban settings will have different characteristics and requirements from those in more rural or remote settings. Even though it may be difficult to predict all the medical needs of the crowd, prior studies have started to use a more scientific approach to addressing these needs. Event type, duration, expected attendance, and weather conditions need to be taken into careful consideration in the planning process.

## PITFALLS

- Lack of legislation regulating minimum standards for provision of medical care at mass gatherings
- Lack of a coordinated, integrated preplanning process
- Lack of funding to provide needed public health initiatives and medical resources
- Failure to identify a medical director for the event
- Failure to learn from previous experiences
- Underestimating expected attendance
- Failure to consider all variables, such as crowd size, demographics, event duration, and environmental factors
- Failure to consider and prepare for a terrorist event or MCI
- Inability to allow capacity crowd ingress to a stadium in a 1-hour period
- Failure to consider ambulance access and egress at an event
- Lack of training of security personnel, leading to failure to recognize and control potentially dangerous situations

## REFERENCES

1. Memish ZA, Stephens GM, Steffen R, Ahmed QA. *Lancet Infect Dis*. 2012;12:56–65.
2. De Lorenzo RA. Mass gathering medicine: a review. *Prehosp Disaster Med*. 1997;12:68–72.
3. World Health Organisation. *Communicable Disease Alert and Response for Mass Gatherings: Key Considerations*, June 2008, Available at: [http://www.who.int/csr/Mass\\_gatherings2.pdf](http://www.who.int/csr/Mass_gatherings2.pdf).
4. Arbon P. Mass gathering medicine: a review of the evidence and future directions for research. *Prehosp Disast Med*. 2007;22(2):131–135.
5. Leonard RB, Petrilli R, Noji EK, et al. *Provision for Emergency Medical Care for Crowds*. Dallas: ACEP Publications; 1990, 1–25.
6. Jaslow D, Yancy A, Milsten A. Mass gathering medical care. *Prehosp Emerg Care*. 2000;4(4):359–360.
7. Jaslow D, Drake M, Lewis J. Characteristics of state legislation governing medical care at mass gatherings. *Prehosp Emerg Care*. 1999;3(4):316–320.
8. Jaslow D, Yancy A, Milsten A. *Mass Gathering Medical Care: The Medical Director's Checklist for the NAEMSP Standards and Clinical Practice Committee*. Lenexa, Kan: National Association of Emergency Medical Services Physicians; 2000.
9. Soomaroo L, Murray V. Disasters at mass gatherings: lessons from history. *PLoS Curr*. 2012 Feb 2;4:RRN1301[revised 2012 Mar 12].
10. Ahmed QA, Arabi YM, Memish ZA. Health risks at the Hajj. *Lancet*. 2006;367:1008–1015.
11. Varon J, Fromm RE, Chanin K, et al. Critical illness at mass gatherings is uncommon. *J Emerg Med*. 2003;25(4):409–413.
12. Arbon P, Bridgewater F, Smith C. Mass gathering medicine: a predictive model for patient presentation and transport rates. *Prehosp Disast Med*. 2001;16(3):109–116.
13. Zeitz KM, Schneider DP, Jarrett D, et al. Mass gathering events: retrospective analysis of patient presentations over seven years at an agricultural and horticultural show. *Prehospital Disaster Med*. 2002;17(3):147–150.
14. Thierbach AR, Wolcke BB, Piepho T, et al. Medical support for children's mass gatherings. *Prehospital Disaster Med*. 2003;18(1):14–19.
15. Milsten AM, Maguire BJ, Bissell RA. Emergence of medicine for mass gatherings: lessons from the Hajj. 2002;17(3):151–162.
16. Football Licensing Authority. *Guide to Safety at Sports Grounds*. 4th ed. London: The Stationery Office; 1997.
17. Grange JT, Baumann GW, Vaezazizi R. On-site physicians reduce ambulance transports at mass gatherings. *Prehosp Emerg Care*. 2003;7(3):322–326.
18. Dutch MJ, Senini LM, Taylor DJ. Mass gathering medicine: the Melbourne 2006 Commonwealth Games experience. *Emerg Med Australas*. 2008; 20:228–233.
19. Hartman N, Williamson A, Sojka B, et al. Predicting resource utilisation at mass gatherings using a simplified stratification scoring model. *Am J Emerg Med*. 2009;27(3):337–343.
20. Baird MB MDa, O'Connor RE MDa, Williamson AL RNb, Sojka BBA, EMT-Pc, Alibertis KBA, EMT-Pd, Brady WJ MDa. The impact of warm weather on mass event medical need: a review of the literature. *Am J Emerg Med*. 2010;28:224–229.
21. Perron AD, Brady WJ, Custalow CB, et al. Association of heat index and patient volume at a mass gathering event. *Prehosp Emerg Care*. 2005;9:49–52.
22. Friedman LJ, Rodi SW, Krueguer MA, et al. Medical care at the California AIDS Ride 3: experiences in event medicine. *Ann Emerg Med*. 1998;31(2):219–223.
23. De Lorenzo RA. Mass gathering medicine: a review. *Prehospital Disaster Med*. 1997;12(1):68–72.
24. Centers for Disease Control and Prevention. MMWE: prevention and management of heat-related illness in many spectators and staff during the Olympic Games—Atlanta, July 6–23, 1996. *JAMA*. 1996;45(29): 631–633.
25. Eadie JL. Health and safety at the 1980 Winter Olympics, Lake Placid, New York. *J Environ Health*. 1981;43(4):178–187.
26. Hewitt S, Jarrett L, Winter B. Emergency medicine at a large rock festival. *J Accid Emerg Med*. 1996;13(1):26–27.
27. Grange JT, Green SM, Downs W. Concert medicine: spectrum of problems encountered at 405 major concerts. *Acad Emerg Med*. 1999;6(3):202–207.
28. Nardi C, Bettini M, Brazoli C, et al. Emergency medical services in mass gatherings: the experience of the Formula 1 Grand Prix 'San Marino' in Imola. *Eur J Emerg Med*. 1997;4(4):217–223.
29. Janchar T, Samaddar C, Milzman D. The mosh pit experience: emergency medical care for concert injuries. *Am J Emerg Med*. 2000;18(1):62–63.
30. Erickson TB, Koenigsberg M, Bunney E, et al. Prehospital severity scoring at major rock concert events. *Prehospital Disaster Med*. 1997;12(3):195–199.
31. Fromm RE, Varon J. Frequency of asthma exacerbations at mass gatherings. *Chest*. 1999;116(4):251S.
32. Meehan P, Toomey KE, Drinnon J. Public health response for the 1996 Olympic Games. *JAMA*. 1998;279(18):1469–1473.
33. Wetterhall SF, Coulombier DM, Herndon JM, et al. Medical care delivery at the 1996 Olympic games. *JAMA*. 1998;279(18):1463–1468.
34. Flynn M. More than a sprint to the finish: planning health support for the Sydney 2000 Olympic and Paralympic Games. *ADF Health*. 2000;1:129–132.
35. Sharp TW, Brennan RJ, Keim M, et al. Medical preparedness for a terrorist incident involving chemical or biological agents during the 1996 Atlanta Olympic Games. *Ann Emerg Med*. 1998;32(2):214–223.
36. Report on WHO support to the 2010 FIFA World Cup South Africa™ Pretoria, South Africa, 27 January 2011.

37. Crouse B, Beattie K. Marathon medical services: strategies to reduce runner morbidity. *Med Sci Sports Exerc.* 1996;28(9):1093–1096.
38. Roberts WO. A 12-year profile of medical injury and illness for the Twin Cities Marathon. *Med Sci Sports Exerc.* 2000;32(9):1549–1555.
39. Ridley SA, Rogers PN, Wright IH. Glasgow marathons 1982–1987. A review of medical problems. *Scott Med J.* 1990;35(1):9–11.
40. Memish ZA. Infection control in Saudi Arabia: meeting the challenge. *Am J Infect Control.* 2002;30(1):57–65.
41. Al-Bayouk M, Seraj M, Al-Yamani I, et al. Treat and release: a new approach to the emergency medical needs of the oldest mass gatherings—the pilgrimage. Presented at: 11th World Congress on Emergency and Disaster Medicine. Free Paper Session Topics and Abstracts, May 10–13, 1999, Osaka, Japan; 2002.
42. Salhanick SD, Sheahan W, Bazarian JJ. Use and analysis of field triage criteria for mass gatherings. *Prehospital Disaster Med.* 2003;18(4):347–352.
43. Crocco TJ, Sayre MR, Liu T, et al. Mathematical determination of external defibrillators needed at mass gatherings. *Prehosp Emerg Care.* 2004;8(3):292–297.
44. Orue M, Pretell R. Mass Casualty in a Pop Music Concert Instead of Being a Programmed Event: Home Fair 1997, Lima, Peru. Available at: <http://pdm.medicine.wisc.edu/moncerrat.htm>.