Mass-Gathering Medical Care: A Review of the Literature

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Abbreviations:
ACEP = American College of Emergency Physicians
BAC = blood alcohol content
ED = emergency department
EMS = emergency medical services
MGMC = mass-gathering medical care
MUR = medical usage rate
NASCAR = North American Stock Cars
NAEMSP = National Association of Emergency Medical Services Physicians
NCAA = National Collegiate Athletic Association
NBA = National Basketball Association
NFL = National Football League
PPTT = patients per 10,000

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Abstract

Mass-gatherings events provide a difficult setting for which to plan an appropriate emergency medical response. Many of the variables that affect the level and types of medical needs, have not been fully researched. This review examines these variables.

Methods: An extensive review was conducted using the computerized databases *Medline* and *Healthstar* from 1977 through May 2002. Articles selected contained information pertaining to mass-gathering variables. These articles were read, abstracted, analyzed, and compiled.

Results: Multiple variables are present during a mass gathering, and they interact in complex and dynamic ways. The interaction of these variables contributes to the number of patients treated at an event (medical usage rate) as well as the observed injury patterns. Important variables include weather, event type, event duration, age, crowd mood and density, attendance, and alcohol and drug use.

Conclusions: Developing an understanding of the variables associated with mass gatherings should be the first step for event planners. After these variables are considered, a thorough needs analysis can be performed and resource allocation can be based on objective data.

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Introduction

Millions of people attend mass-gathering events every year. In the United States, 5.5 million attended North American Stock Car (NASCAR) events and 165 million attended National Basketball Association (NBA), National Football League (NFL), and/or and National Collegiate Athletic Association (NCAA) events.[1,2] Although most of the medical care needed at these events is of minor severity, an effective emergency medical system capable of handling any life-threatening condition must be ready at all times to respond, assess, and treat. The medical care provided at these large events has been named Mass Gathering

Medical Care (MGMC) by the National Association of Emergency Medical Services Physicians (NAEMSP). The label 'special event medical care' also has been used, and has been defined as "the provision of preventive measures, or definitive, primary medical care, or hospital referral to persons attending or participating in major sports, recreational, or political events."[3] Other authors feel that this definition is "vague" and "not appropriate."[4]

One of the main problems for the providers of MGMC has been the lack of standard and formal guidelines that can help direct local providers who must supply coverage for an event.[5,6] Several groups, including the American College of Emergency Physicians (ACEP) and the NAEMSP, have attempted to address this problem by publishing position papers and guidelines.[7,8] The complex interaction between many of the variables associated with mass gathering events has made the planning and establishment of formal guidelines difficult. Conflicting reports on the different variables fill the literature. This review summarizes these differences and reaches some conclusions about which of them should be considered by the emergency planners.

Mass gatherings medicine is concerned with the provision of emergency medical care at organized events with >1,000 people in attendance.[2,5,6,9–11] Even though a number exists defining MGMC, most published reports have described the medical aspects of events with >25,000 people in attendance. Furthermore, most of the analyses have been descriptive, and few analytical studies have been reported.[9] Some authors have added to this definition. Mears noted that MGMC should involve >1,000 people at one site or location and that other situations in which people are crowded together and/or isolated from emergency medical services (EMS) also should be included (e.g., planes, trains).[12] Even this definition does not address situations such as the Olympics in which spectators and participants may be spread across long distances and multiple sites. But, the situation at Stapleton Airport, when 10% of Denver's EMS call volume centered on the airport, supports the concept that MGMC extends to other arenas.[13] Michael and Barbara consider MGMC when more than 1,000 people come together for a specific purpose in a variably sized site for a variable amount of time.[14] Medical care for populations of displaced persons (disaster victims, internally displaced persons, and refugees) also has been labeled a MGMC.[4] Finally, some authors have noted that no clear definition exists for MGMC, and that the >1,000 number has been derived from staffing requirements.[11]

Despite the disagreement over the definition of a MGMC, for the most part, the goals for the medical care provided are the same. The incidence of illness and injury remains higher than would be expected for a non-unrefined population of similar size.[15] Therefore, even though mass gatherings tend to be collections of "well-persons",[6,16] emergencies do occur with an increased frequency, and emergency medical care readiness is required.

A MGMC has several goals including the provision of on-site event medical care, as well as the preservation of the abilities of the EMS system to provide the rest of its services.[14] On-site medical care can be broken down further into rapid access to the patient, triage, stabilization, and transport without "needless delay to definitive care," and facilities that handle minor injuries and illnesses.[10,15,17] A MGMC must include the capability to respond to emergencies such as sudden cardiac death. Triage separates minor complaints from serious injuries, and arranges for timely treatment and transport to an appropriate location.

One of the goals of MGMC has been preservation of the functionality of the local EMS system. As with other events in Disaster Medicine, regular EMS calls will continue despite the on-going mass gathering. The required medical care at a large event can draw on the local EMS providers for staffing, but often, extra help and part-time personnel must be used.[18,19] Local facilities, such as schools, may be converted into temporary treatment centers.[20] The effects of a mass-gathering on the local community are not entirely clear, although a British Emergency Department (ED) volume study failed to show an increase in activity level during an international sporting event, and the 1996 summer Olympics affected the local EDs "minimally".[21,22] Despite the possible effects on EDs and EMS volumes, planning for mass gathering needs to be integrated with the local EMS system[23] and cannot operate in a vacuum.

Methods

An extensive review of the available literature from 1977 through May 2002 was conducted using the computerized databases *Medline* and *Healthstar*. Articles were selected for inclusion if they contained information pertaining to mass gathering variables or injury-illness patterns. Selected articles were read, abstracted, analyzed, and compiled. Abstracted data were reported as a percentage of visits or as patients per 10,000 (PPTT) persons in attendance, which represents the medical usage rate (MUR). The PPTT was calculated by dividing the number of patients treated by the number of attendees, and then, multiplying by 10,000.

Results

Weather and Environmental Factors

There are many anecdotal and descriptive case reports concerning hot weather and its effects on persons at mass-gatherings events. Papal visits to San Antonio and Denver resulted in many persons with heat-related illnesses.[20,24,25] There are numerous case reports of heat-related illness during concerts,[18,19,26] and political demonstrations (Tables 1 and 2). In one instance at a Denver rock concert, a black tarp placed on the field created a "heat island," which increased the temperature from the 90° to 120°F (32° to 49°C). (Table 3).[28]

Multiple, retrospective studies also have demonstrated the effects of increased temperatures on people at mass gathering events. These studies include analysis of patient data from the "California AIDS Ride" as well as the 1996 Summer Olympics in Atlanta (Tables 1 and 4).[29,30]

Several mass gathering events have reported weather changes that occurred during the event, illustrating the higher number of patients expected at warmer events. Two case-reports from Woodstock 1994 note severe weather changes mid-way through the concerts.[18,19,26] Other

Study	Year	Study Type	Contributing Factors or Study Problems	Reference
San Antonio Papal visit	1988	Anecdotal case-reports	200 medical encounters (90% heat-related). T= 100°–106°F Heat treatment stations located inside buildings with air conditioning, "wet-down" locations.	24
Denver Papal visit	1993	Anecdotal case-reports	"Rampant" heat exhaustion. T= 84-89°F, dropped to 56°F at night (with rain). Predicted attendance was 250,000 (500,000 arrived) Heat exhaustion worsened by: altitude, high crowd density, physical exhaustion & dehydration (14 mile hike proceeding the Mass), insufficient number of portable toilets with long waits, many spectators stopped drinking fluids in order to avoid the long wait for a toilet, poor nutrition from eating "junk food" and drinking canned sodas (instead of water), unmarked free water taps. Weather change mid-event: Spectators cooled with hoses during day, were now shivering at night; all night vigil.	20,25
World's Fair and Energy Exposition (Knoxville, Tennessee)	1982	Health surveillance of 23 EDs, the Fair's infirmary, and the local EMS system	Combined multi-agency effort Public health initiatives reduced heat-related illness: media used for public education, additional drinking fountains installed, black-tops painted white, cooling tents. High school band members: marching in full dress uniforms, avoiding long waiting periods prior to marching, lighter uniforms.	72
Atlanta Summer Olympic	1996	Retrospective chart review	Heat-related patients (12%). Most were minor & seen in the afternoon Heat-related illness was 2% of local ED volume and increased to 4.2%. Combined multi-agency effort with the Georgia Department of Public Health: free water sites, media used to promote public education, distribution of free water/hats/sunscreen packages.	29
Woodstock	1994	Anecdotal case-reports	Rain with 30°F drop during concert 350,000 "wet, exposed citizens". Weather change mid-event: mud due to rain, leading to "mud people" as well as increased injuries (fractures and sprains), rewarming tents used, "Many" spectators had to be transferred off-site, requiring three patients per ambulance.	18,19,26
Denver's Mile High Stadium	1978	Retrospective chart review of one season (10 home games)	720,000 attendees, 298 treated, MUR=4/10,000 attendees Higher MURs during the earlier (and hotter) part of the season. Common diagnoses during hot weather games included syncope, headache and trauma due to alcohol Decreased staffing needs during cold weather games suggested.	32
9-day Royal Adelaide Show	1991	Retrospective chart review of 1,276 patient questionnaires	140,000 attendees, 1,276 treated, MUR=91/10,000 attendees Variation in MUR correlated best with variations in temperature and not with daily attendance. Highest MUR on day 6 and on weekdays.	33
NYC Central Park Papal Mass	1995	Retrospective chart review	130,000 attendees, 55 treated, MUR=4/10,000 attendees T=50-60°F with rain; no hypothermia case.	67
Cross-country ski marathon	1984	Retrospective chart review	8,000 attendees, 353 treated, MUR=441/10,000 attendees, T=26°F with calm wind and variety of terrain Increased hypothermia & exhaustion towards the end of the race . More abrasions and falls after a steep icy downhill section. Inexperienced marathoners had more problems.	82

Table 1—Weather and environmental factors (Medical usage rate (MUR) reported as numbers of patients per 10,000 (PPTT) in attendance; T = Temperature)

events marked by drastic weather changes included the 1971 Glastonbury Fair and the Denver Papal visit.[20,25,31] Some retrospective studies examined mid-event temperature shifts as well (Denver's Mile High stadium and the Royal Adelaide Show) (Tables 1 and 3).[12,12,32,33]

Alcohol and Drug Use

Alcohol and drug use patterns at mass gathering events have been explored as a potential variable. Studies from concerts in the 1970s, such as the Glastonbury fair and Watkins Glen, provide evidence of rampant drug and alcohol use

Study	Year	Study Type	Contributing Factors or Study Problems	Reference
Papal visit to New York City at Aqueduct Racetrack	1995	Retrospective chart review	74,710 attendees, 139 treated, MUR=19/10,000 in attendance T 85°F & no water was sold inside the Racetrack. Many people did not want to eat or drink prior to seeing the Pope. 64% were > 50 years of age: Regular medicines missed, exacerbations of preexisting medical disease, help returning to their vehicles needed, patrons just needing a place to rest.	67
Summer Olympics	1996	Observational cohort study with review of the medical records	Athletes: younger (age in 20s) than the staff and trainers (average age in 40s), musculoskeletal injuries 2x more frequent (51.9%). Spectators: Heat-related illness most common (88.9%), spent more time outdoors (walking, public transportation). Staff: Upper respiratory tract infections, diabetes, and hypertension exacerbations common among staff. 8 local hospitals monitored and there was no significant change in the number of patients they saw from baseline.	69
One concert, three football games and four basketball games	1986	Survey of medical care at 15 public facilities	Event classification: category 1 (seated events of shorter duration <6 hours); category 2 (mobile events of longer duration >1 day). Categories: ALS and BLS level of care the same, lacerations, abrasions, and extremity sprains/fracture most common, poor documentation, prehospital personnel would dispense medical advice without involving a physician, with little quality assurance.	10
Anti-War demonstrations in Washington, DC	1969–1970	Anecdotal case-reports	Three "completely peaceful" marches & 2 unsanctioned demonstrations by militant groups . The crowd (including protesters, police, bystanders, & medical staff) was barraged with tear-gas (CN & CS); 5,000 treated for exposure. Other issues: asthma exacerbations, avoiding panic and possible trampling/crushing, 1,000 heat-related cases (100,000 attendance).	27,37
NASCAR Winston Cup event	1997	Retrospective chart review of 3-day event	214,000 attendees, 923 treated, MUR=43/10,00 attendees. No change in MUR during course of event and no change with the higher attended days. Drivers and crew were 4% of the total patients seen.	1
Summer Olympic Games in Atlanta	1996	Examined the population influx's (3 million people) effect on local pediatric ED	The presenting children tended to be sicker than the usual ED population (higher admission rate), but had common childhood illnesses. There was only a minor impact on local emergency services and the biggest issue was due to improper preparation by the families for travel (such as forgetting to pack the child's medicine).	22
Calgary Winter Olympic	1988	Retrospective review of 3,395 charts	1,800,000 attendees, 3,395 treated, MUR=19/10,000 attendees. Low-acuity injuries and illnesses (87%). Low-acuity viral syndrome (24%) and gastrointestinal illness (Most patients with low acuity viral syndrome were requesting analgesics or cold remedies). Cold-related illness or injury accounted for only 1% of all cases Musculoskeletal complaints were still the most common. Physicians were not needed with ALS paramedic crews in urban areas.	2,16

Table 2—Weather and environmental factors (Medical usage rate (MUR) reported as numbers of patients per 10,000 (PPTT) in attendance; T = Temperature) **(Continued)**

Study	Year	Study Type	Contributing Factors or Study Problems	Reference
California concerts	1998	Retrospective review of 405 single-day concerts compared the PPTT to four variables: music type, overall attendance, temperature and indoor versus outdoor	4,638,099 attendees (for all concerts), 1,492 treated, MUR=3 Rock concert MUR=137; Non-Rock concert MUR=71 Punk festival (with a riot): highest MUR=71; trauma-related injuries (76%), head injuries (49%). Classical music events: 4 cardiac arrests (0.9 per million people overall and 1.9 per million per classical concert attendees). Gospel/Christian: Consistently had the highest MUR (13), when each concert considered individually (however, there were only three concerts studied in this area and this could represent chance alone). Alcohol & Drug use: 11% out of 1,492, mostly at rock concerts (compared to non-rock concerts), alcohol and drug use not routinely assessed, leading to an underestimation of the actual rate of usage. Concert-to-concert variability was much higher than the predictive value of the music type.	40
Lollapalooza	1993	Anecdotal case-reports for 3-day event	Logistical issues included: continued regular EMS coverage, equipment supply issues, local hospital overload, multiple strike teams would often treat/release/AMA patients. Weather issues: T 95-100°F, heat-related illness common, drinking water supplies ran low, no coolers allowed in concert, minimal rain and dry turf led to respiratory illnesses (after a bronchodilator treatment, most patients would refuse further treatment or transport), crowd sprayed with cool water.	83
3 outdoor stadium concert events	1999	Retrospective chart review	180,000 attendees (for all concerts), 1,542 treated, MUR=83 Moshing accounted for 37% of injuries (MUR-25). More transports were noted among mosh pit injured patrons.	84
Summer rock concert festival	2001	Retrospective chart review of 2-day Taipei concert	50,000 attendees, 28 treated, MUR0=6 ALS care required for more than half the patients	85

Table 2—(Continued) Weather and environmental factors (Medical usage rate (MUR) reported as numbers of patients per 10,000 (PPTT) in attendance; T = Temperature)

(8–14%).[31,34–36] Anti-war demonstrations from 1969 and 1970 reported less drug use (3–4%) (Table 3).[37]

Retrospective studies from Toronto and US Festivals during the 1980s found a lower incidence of drug and alcohol usage than was reported during the 1970s.[9,11,38,39] Other more rigorous studies, though, show higher incidence of usage and alcohol-related medical incidents.[32,36,40–42] A Chicago concert series found an alcohol and drug usage rate of 27% among patients, but specifically asked about alcohol or drug use (Tables 3 and 4).[36,42]

Several studies have examined the incidence of alcohol or drug cases at sporting events, such as 1984 summer Olympics (0.4%), and college football (Tables 2 and 3).[3,28,40,43] A recent, prospective study indicated a higher level of alcohol use among patrons than what has been recorded in the first-aid stations. In this study, 747 male patients at three major league baseball games allowed their blood alcohol levels to be analyzed. The authors found that 41% of the tested patrons were positive for alcohol (most in the 20–35 year-old age group), with 11% being legally intoxicated (BAL = 0.08%).[44]

Attendance and Crowd Density

Weaver and colleagues analyzed data from the 1986 World's Exposition[45] and found a weakly positive linear correlation between gate attendance and daily patient load (a five-month event with 22 million attendees) (Table 1). Absolute patient volumes tended to decrease with higher attendance.[3,12,33,46] Michael and Barbera found that as the number of spectators increased (increased spectator units), the number of patients evaluated (per 10,000 in attendance) decreased. Events with >1,000,000 spectator units evaluated an average of 10 patients per 10,000 spectator units; whereas events with <1,000,000 spectator units averaged 41 patients per 10,000 spectator units.[14]

Event Duration

Data analysis from the 1982 US Festival and Royal Adelaide Show indicate higher medical usage rates after multiple days.[12,33,39] On the other hand, some studies have not identified any change in medical usage rates with prolonged event duration (Tables 1 and 4).[30]

Study	Year	Study Type	Contributing Factors or Study Problems	Reference
Vermont rock-festival	1973	Anecdotal case-reports of 48 hour event	35,000 attendees, 241 treated, MUR=69. Drug & alcohol use: 10% (out of 241), "widespread use of drugs and alcohol", LSD was the principle drug abused, drug use often obscured diagnosis, separate van used as "drug overdose unit". Many of the spectators were "modern day gypsies" and arrived 2 weeks prior to the event.	34
Glastonbury fair	1971	Anecdotal case-reports and summary of 4-day event	150,000 attendees, 1,151 treated (350 treated by MD), MUR=77. Drug & alcohol use: Many patients treated for drug-related issues, mostly minor and few needed pharmacological interventions, high LSD usage, on-site mental health professionals needed in the "bad trip tent". Weather change mid-event: First few days were wet & many spectators were barefoot (foot problems); Last few days were hot & dry (sunburns and hay fever).	31
Watkins Glen Rock Concert	1973	Medical and toxicological evaluation of weekend long event	600,000 attendees with 363 medical encounters (MUR=6.0). Drug & alcohol use: 8% (out of 363), on-site lab analyzed 76 solid dose samples (75% misrepresented or adultered), downers were principle drug, supportive care (not talk-down methods) used. "frequent use of psychoactive chemicals at these large gatherings is to be anticipated" and will mirror the drug abuse patterns and attitudes of societal youth.	35
Outdoor "new wave" Toronto rock festival	1980	Retrospective chart review of 36-hour event	30,000 attendees, 488 treated (134 treated by MD), MUR=162 Drug & alcohol use: 3% (out of 512), most were minor cases, many patrons would consume their entire alcohol or drug supply prior to entering the gates (to avoid confiscation), high rate of drug misrepresentation.	38
College Football	1995	Retrospective chart review of 1 season (7 home games)	485,989 attendees, 526 treated, MUR=11. High MUR despite alcohol ban (MUR=11 per game). Hot and humid climate. Increased number (6 stations) and visibility of first-aid stations.	43
College Football	1983-1986	Retrospective chart review. MUR evaluated pre- and post-alcohol ban	1,264,341 attendees, 340 treated, MUR=3. No change in MUR between pre and post ban time periods Ineffective bag searches, poor monitoring and enforcing, extensive alcohol and drug smuggling, altered drinking patterns. Inability to determine the exact incidence of alcohol usage. Privacy issues and laws prevent thorough bag searches . Safety concerns about weapons.	28
Chicago concert series (5 concerts)	1996	Retrospective chart review	250,000 attendees, 308 treated, MUR=12 Alcohol and drug use rate of 27%. 21% of trauma complaints due to drug use (fighting). The medical staff at these events specifically asked about alcohol and drug use. When patients asked, half admitted to using some drug. Cannabis was the most commonly drug overall. Significant hallucinogenic agent use (LSD, PCP, psilocybin). DRISS-ROCK severity scoring system used.	36,42

Table 3—Alcohol and drug use (Medical usage rate (MUR) reported as Patients per 10,000 (PPTT); T = Temperature)

Event Type

Event type is one of the most important variables that an event planner must consider. Different event types can have their own unique issues that must be addressed.

Crowd Mood

Crowd mood is an important, yet unpredictable variable.[47-49] This variable may be affected by the music type, the rivalry between sporting teams, or a religious "revival" atmosphere.[24] Most of what has been written concerning crowd mood comes from the laypress or from anecdotal reports. Crowded concerts may give attendees feelings of "crowd syndrome", "too-close-for-comfort", and "too-many-rats-in-a-cage paranoia".[50] Other events also can impact on the crowd's emotional state including the chaos that occurred after the Olympic bombing in Atlanta and "epidemic hysteria" (an unexplained phenomenon that occurs in younger persons, where one person becomes symptomatic, and this symptom pattern rapidly "spreads" to others).[13,51]

Study	Year	Study Type	Contributing Factors or Study Problems	Reference
US Festival	1982	Retrospective chart review of 3-day event	410,000 attendees, 2,623 treated, MUR=64. Increased MUR found on the last day of festival (but had the lowest attendance): cumulative morbidity; the last day's increased MUR could have been due to an older crowd (older crowd expected for 1960's music), but accurate age & demographic were not available. Day 1 was punk rock (visit incidence 0.55%), Day 2 was new wave (0.50%), Day 3 was contemporary rock (1.05%) Drug & alcohol use: 1.9% drug issues, 1.3% alcohol issues. Extensive bag searching at the gate. General societal trend of decreasing drug use.	39
California AIDS Ride 3	1996	Retrospective chart review of 7-day event. Patient encounters requiring physician interaction specifically examined	2,650 riders, 25,379 medical treatments, 509 treated by MD. Heat-related illnesses accounted for 31% of the physician encounters (and increased on warmer days) with few requiring off-site transport; one day had T = 109°F & 70% of cases were heat-related (most seen in the afternoon). MUR did not increase towards the end of the event (authors were not specifically looking this). Heat exhaustion worsened by: outdoor event, hot weather, higher level of pre-existing disease among the participants and varying degrees of athletic conditioning.	30

Table 4—Event Duration (Medical usage rate (MUR) reported as Patients per 10,000 (PPTT); T = Temperature)

Study	Year	Study Type	Contributing Factors or Study Problems	Reference
Outdoor music festival held on a private farm in England	1989	Retrospective chart review of 3-day event	Predicted attendance was 6,000 (75,000 arrived): only three portable toilets which quickly broke down, water supply was vandalized and insufficient, understaffed first-aid tent, two children were run over by vehicles while sleeping on the ground. Gastroenteritis outbreak.	64
College football and basketball, and rock concerts	1980-1986	Retrospective chart review of patient frequency and attendance	Negative correlation between crowd size and the MUR for sports. Mildly positive correlation for concerts.	46
Summer Olympics	1984	Retrospective chart review of data from 9 Summer Olympics sites with >10,000 spectators	3,447,807 attendees, 5,516 treated, MUR=16. Highest MUR (21) at outdoor events with mobile spectators and a crowd capacity of <30,000. MUR (15) for sites with seated patrons. Large crowd dilutional effect. Crowd mobility led to higher MUR.	3

Table 5—Attendance and Crowd Density (Medical usage rate (MUR) reported as Patients per 10,000 (PPTT); T = Temperature)

Events with political overtones can influence the crowd mood as well.[37] Brunko pointed out that although predicting the collective mood seems to have worked for the Papal visit in Denver, predictions generally have been unreliable.[7,50] Nevertheless, Brunko covered a rock concert in Denver with a medical usage rate of 60 PPTT, and felt that the collective mood as well as the weather were key factors.

Most of the articles dealing with crowd mood have focused on rock concerts and festivals. Erickson quotes from the Wall Street Journal:

> A lot of kids come to shows with the expectation of experiencing minor trauma or battle scars. It is a status symbol to leave a little bloodied or at least bruised. Heavy metal bands clearly attract the most rambunctious crowds; reggae shows are relatively sedate, thanks to the soothing effects of marijuana. However, you'll never see an LSD problem at a Barry Manilow concert.[36]

Mood at Woodstock 1994—The mood of the crowd on the first day of the concert was somewhat aggressive. People were staking out territory to pitch their tents, and no one was particularly helpful to anyone else. On Saturday, however, after the rains came, the mood of the crowd underwent a major transformation. People began to help one another, and a sense of community took over.[19]

The media has focused on the various Woodstock events, especially after the riots during 1999. Riots among 200–500 people broke out towards the end of Woodstock 1999, and there have been several explanations for these

events. Spectators blame the concert promoters of having a "profit mentality" and overcharging for food and drinks ([US] $4 for a bottle of water) with sparse free drinking water, overcrowding, squalid living conditions, high ticket prices, overflowing toilets, and no garbage collection services.[26,52,53] This type of concert is compared to festivals of "jam bands" that play without the benefit of corporate sponsors, and try to keep the events non-commercial.[54] Even Woodstock 1969 (the "goodstock" made so by movies and selective memories) had serious problems with food shortages, overflowing toilets, lack of medical supplies, bonfires, damaged property, and drug-related overdoses and deaths.[52]

The concert promoters blamed the spectators for the riots, saying that Woodstock 1999 was filled with "ogling, molesting and lewd, condescending behavior by fans" (four rape charges were filed) and that the spectators wanted to see "how far things would go without anyone being harmed."[52] Some felt that the type of music played influenced the crowd's actions.[53] It is interesting to point out that the riots occurred on the last day when the "quieter acts" were playing and anti-war "peace candles" had been distributed, as opposed to the day before when the heavy-metal bands were on stage.[26,53] Strauss further commented on the riots.

> Mayhem and destruction at organized mass gatherings isn't generational. It is timeless, as are motivations for it: money, testosterone, intoxication, arrogance, boredom, and repression.[52]

Discussion

Not all mass-gatherings are equal. There are multiple variables that can change the character and flow of a mass-gathering event, and these can affect injury patterns and medical usage rates (MUR). The American College of Emergency Physicians (ACEP) outlined several variables that should be considered by event planners including: alcohol and drug availability, "type" of people participating, age distribution of the attendees, event duration and the time it occurs, mobile or stationary event, attendance expected, event type, presence of fireworks/torches/bonfires, physical plant and location characteristics, outdoor or indoor event, and weather.[7] Levitin added access routes to and from the site and the number (and visibility) of first-aid stations to this list.[2] The ACEP also noted that attendance can be anticipated by advance ticket sales or past experiences. The type of event will determine the approximate age range of those attending, and location characteristics will determine physical barriers to medical care.[7] The physical layout of the event will determine crowd flow, access roads for rapid transport by EMS and staging areas, and other physical barriers (which can be uncommon and require different models in an area such as Yellowstone National Park).[55,56]

Weather and environmental factors constitute a major influence at mass gathering events. Excessive heat without adequate hydration can be lethal. In Chicago July 1995, more than 500 people died over a four-day period due to a heat wave. Chicago had been experiencing normal summer temperatures, but the humidity was markedly elevated.[23] Heat-related deaths have been reported among marathon runners (body temperature - 107°F (41.7°C)), despite cool overall conditions (47°F (8.3°C)).[57] Hot weather generally predisposes to dehydration and heat-related illnesses whereas cold weather can lead to hypothermia and frostbite.[6,25] Minor heat-related illness and heat exhaustion are more common than is heat stroke.[36,49]

Several conditions can worsen the morbidity and mortality from heat-related illness, including, dehydration, fever, infection, lack of recent heat exposure, insufficient training, alcohol abuse, sunburn, lack of sleep, excessive clothing, and diarrhea or vomiting.[35] Also, use of certain medications can lead to higher morbidity, such as anticholinergics, sympathomimetics, and neuroleptics.

Increased temperature (at the time of the event) increases the medical usage rate. Heat-related illness is one of the most preventable diseases and public health initiatives can help in this regard.[41] This was seen at the World's Fair and the Summer Olympics in Atlanta.[23,29] Rock concerts may not allow certain public health measures because of safety concerns (i.e., water bottles are not distributed because they subsequently are used as missiles).

The literature supports what should be intuitive; cold and wet rainy days lead to cold-related illness (hypothermia, frostbite) and more falls from wet grass. Hot weather leads towards higher medical usage rates, heat-related illnesses, dehydration, insect bites and sunburn.[6,47,48,55] Cold weather events generally seem to produce lower casualty rates.[9,58,59] Hypothermia will be increased at events with water (i.e., swim meets or triathelons), rain, or where alcohol is used by the particpants.[6,32]

Alcohol and drug use still is a vague variable that can be difficult to predict, beyond the casual association that young spectators at rock concerts have a relatively higher level of drug and alcohol use than do older spectators. The uses of these chemicals may lead to more trauma, altercations, and car crashes.[47]

This concern is not limited to rock; drugs have been associated with all types of music. Jazz in the 1920s through the 1930s was associated with cocaine and cannabis, and "beatnik" folk music of the 1960s was related with hallucinogens.[60] However, unlike other music genres, rock music included lyrics about drug use and was meant to "enhance drug taking".[60]

Drug use at rock concerts was common during the 1970s. LSD was the principal drug abused (others found include methedrine, mescaline, cannabis, methaqualone, barbiturates, and alcohol).[34] Farrow found increased drug use during the last 24 hours of the three-day festival, as well as increased requests for methadone.[61] Schlicht suggests that there were many external factors that could have affected how these patients reacted to drugs, including lack of sleep, improper food and shelter, police actions, loss of money, and separation from friends.[62]

The literature from the 1970s concerning drug and alcohol use shows a high usage rate (8–14%), but most of the related illnesses were minor.[49] The articles do not examine patient demographics, such as age and gender of patients, associated with drug or alcohol use at mass gathering events. Only Schlicht notes an average age range of 16–20 years for patients with drug histories.[62] Olser and

Farrow note that more males were treated, but there was no statistical comparison and more males attended these concerts.[34,61] Alcohol has been considered a key variable, and can lead to increased medical usage rates. Collected drug samples should be sent to a laboratory, as there is a high rate of misrepresentation.[38,47]

Even though no change in the medical usage rate was found when alcohol was banned at sporting events, alcohol and drug use is commonplace. A review that examined 37 events over a 25-year period, noted that alcohol and drugs (intoxicants) "are more prevalent at rock concerts and sporting events, and thus, influence the number of patients seen, probably more so at rock concerts because of the likelihood of injury to the mobile and intoxicated spectator."[15]

The number of persons in attendance at an event has been widely assumed to be an important factor in determining medical usage rates.[4,6–8,11,13,34,41,48,49,55,63] Whether or not attendance is an important variable and if medical usage rates can be predicted based on estimated crowd size is not clear. Most of the literature indicates that absolute patient volumes tend to decrease with higher number of persons in attendance.[3,14,33,46]

An editorial noted that medical usage rate was "roughly predictable" based on crowd size and the duration of the event.[15] Some authors have noted that the medical usage rate can be predicted based on anticipated crowd size.[30,41] For events that occur at a fixed location, anticipated attendance can be determined from past events, whereas predicting crowd size for one-time events has been unsystematic.[9,55] Furthermore, there are several anecdotal reports and retrospective reviews that illustrate the possible danger and increased morbidity of inaccurately predicting attendance.[20,25,64]

The duration of an event is another variable that often is mentioned as important to determining the patient load.[3,4,6,9,10,12,14,15,34,39,49,55,62] As with attendance, the effect event duration has on medical usage rates also is not clear. However, most of the evidence points towards a positive effect and planners can use Sander's classification system to assist them in planning.[10] For certain events, spectators arrived days before the event and camp-out and stayed for days after the event concluded.[55,65] This does not affect the "event's" duration, but can impact duration of time during which people are dependent upon the local EMS system for health care services. Events that have spectators living on-site or camping out in tents days beforehand probably will generate more patients. These usually are multi-day events, and the spectators' medical resolve may be diminished after a few days in austere conditions without proper food, shelter, sanitary facilities, and sleep.

Event type is an important mass gathering variable, and there are unique aspects inherent in each type. Regardless of event type, there are several important variables that should be considered, including, indoor vs. outdoor, general admission vs. assigned seating, and crowd demographics. A classification system was introduced by Sanders to address these issues, in which Category 1 represented seated events of shorter duration (<6 hours) and Category 2 consisted of mobile events of longer duration (>1 day).[10]

An event either can be indoors or outdoors, with more being written about outdoor events. During the planning process, certain common sense situations should be considered that relate to the local physical plant (either outdoor geography or indoor hazards) as well as barriers (natural and man-made). As Leonard points out,[7] drowning victims are possible if there are bodies of water nearby, fall victims are possible if there are elevated areas, snake bites, contact with poison ivy, and insect bites can result if woods or dense brush are close to the site. Outdoor events without shaded areas can lead to exposure, sunburn, and other environmentally related injuries.[6,7,9,48,64] On wet, rainy days, spectators can be exposed to the cold and also risk slipping down hills and falling.[48] Large events, like the Olympics, also may spread the spectators over several miles and terrain resulting in different climates.[12]

Indoor events have specific problems also. Temperature issues are not as prominent and environmental injuries may be reduced, but routes of ingress and egress need to be established early. Systems for accessing patients in the stands as well as during busy half-time breaks also must be arranged.[6,46,47,55]

Events at which the crowds are mobile (general admission) versus seated (assigned seating) generally have had more persons injured. This was seen in a retrospective chart review from the 1984 summer Olympics.[3]

Generally, certain crowd demographics are associated with different types of events. Planners anticipate an age distribution for a given event, and try to determine medical needs based, in part, on this distribution. The 1995 Papal visit to the New York City Aqueduct Racetrack as well as data from classical music concerts and large sporting events, illustrate some of the medical and social issues associated with older patrons.[13,14,40,67–69] Rock concerts and auto racing events are associated with younger crowds (including unaccompanied minors), whereas a fair will be attended by persons in all age groups.[6,47,48,55,66] Furthermore, different types of music draw different types of spectators, and the issue of crowd mood may play a role. However, age cannot always be relied on as a factor that will determine the preexisting health of a crowd. The "Concert for Life" in Australia had a high percentage of cardiac transplant, as well as AIDS patients, and the California AIDS Ride also had a large number of riders with AIDS.[6,30]

Some events may lead to serious trauma or violence; such as accidents at an auto race, tear gas exposure at an anti-war rally, riots at a concert, injury during the Olympics (alpine ski area), and crowd crush and activities in mosh pits during a concert stage rush.[6,27,37,40,55,70]

Each type of events has its own unique aspects, in addition to the variables already reviewed. Each of these may affect the patient load. At auto racing events, there is a threat of serious trauma to bystanders, drivers, and the track crew. These threats are worsened by the potential for high-speed accidents and the use of poorly-constructed stands or scaffolding for seats.[1,55,71]

Another unique event that has been described anecdotally is Papal visits.[24] Federman and Giordano described the New York City Emergency Medical Services (NYC-EMS') planning process and subsequent injury patterns in more rigorous detail.[67] Two aspects of a Papal visit seem to

Variable	Possible Causal Factors	Outcome (+ or -)	References
Weather	Heat and cold exposure Lightning Precipitation	+ with heat +/- with cold	3,6-9,12,18,24,30,33,39-41,49,50,55,67
Attendance	Dilutional effect Staffing levels Fixed location events, may anticipate attendance by past events or ticket sales Crowd size predictions for one-time events is haphazard	+/- to mild -	3,46,64
Duration of Event	Extended exposure Incubation periods elapse Increased exhaustion Cumulative morbidity	Mild +	4,7-9,12,14,15,30,34,39,40,49
Outdoor vs. Indoor	Exposure to temperature extremes Exposure to sun and geographical objects Crowd mobility	+ for outdoor	3,7,8,12,40,49,50,55
Seated vs. Mobile	Exposure to hazards when mobile Increased crowding when mobile Risky behavior	+ for mobile	7-9,12-14,40,41,55
Event Type	Music: drugs, alcohol, duration, mobility, age Sports: alcohol, hazards of sport	+ for rock concerts + for papal masses - for classical music +/- for sporting events	3,7,8,14,34,39,40,41,50,85
Crowd Mood	Music type Revival aspect Team rivalry	+/-	9,13,39,40,48,49
Alcohol and Drugs	Toxicological effects of polysubstance abuse Misrepresentation of drugs Drug-drug interactions Dose and route – binging at the gate Decreased coordination and judgment Increased violence Direct physiologic effects	+	7,9,12,14,39,40,41,49,55
Crowd Density	Increased exposure to microbes Affects on mood Decreased access to patients Decreased access to water, family and bathrooms	+/-	9,12,33,34,39-41,49
Locale/Physical Plant	Barriers to ingress and egress Protection from the elements Exposure to hazards	+/-	4,6-8,13,14,48,55
Age	Behavior and judgment Frailty and vulnerability	+/-	8,24,30,55

Table 6—Variables and their possible causal relationships. (+ represents an increase; – indicates a decrease)

be unique. First, generally there are more elderly persons in attendance. New York City and South Carolina dealt with a large number of elderly patients, but this was not seen in Denver (World Youth Day could account for this) or Detroit.[24,67,72] Another unique aspect of Papal visits is the assumed absence of alcohol or drugs (this has not been tested).

Events of larger magnitude and longer duration, such as the Olympics and World's Fair, often have more extensive medical capabilities on-site, and see a greater number of people.[14,73] There are numerous articles dealing with the emergency medical care provided during the Summer Olympics (or a sporting competition like it).[3,22,74–76]

When planning for medical coverage at the Olympics, the public health issues and the threat of terrorism also had to be addressed. Multiple articles have dealt with the public health issues surrounding the Olympics, and these mostly have dealt with prevention of heat-related illness and gastrointestinal diseases.[29,58,77,78] Local, state, federal, and military resources combined and established a "specialized incident assessment team and science and technology center." This team stockpiled antidotes and antimicrobials, trained first-responders, augmented surveillance systems, and identified weak areas.[79,80] Pediatric emergency departments, as well as the Poison Control Center, also participated in the extensive contingency planning.[22,81]

There also are numerous articles that deal specifically with emergency medical planning during the Winter Olympics. Most of these articles are anecdotal reports and discuss with how a responsible EMS system should be set-up.[2,16,51,58,59]

Concerts often have higher medical usage rates. There are several variables that are thought to increase the medical usage rate at concerts, including age, presence of alcohol or drugs, type of music, and the crowd mood. Erickson noted the average age of concert attendees was 26 years, while 10% were minors. Furthermore, different ages were noted for different music types (24 years for the Grateful Dead versus 30 years for the Rolling Stones). Rock concerts are notorious for large, unruly crowds with a high incidence of trauma that is related to alcohol/drug use, and "moshing".[36,42] Michael and Barbara found that more patients were treated and transported from rock concerts and Papal Masses than from sporting events. More patients suffered cardiac arrests at Papal Masses and sporting events than at rock concerts.[14]

Different music types can affect the medical usage rate.[50] Osler *et al* made some generalizations concerning music type, including that classical/folk and bluegrass concerts attract a smaller, more peaceful crowd than do jazz or hard rock concerts. They noted that jazz and hard rock attract larger crowds, and there are episodes of violence.[34,39,40]

Summary

Multiple interacting variables add an element of uncertainty and difficulty to mass gathering event planning (Table 6). Understanding the variables can make this planning process more effective and streamlined. Though interactions with the event promoters, local and stadium officials, and event organizers are not covered in this paper, prediction and staffing models have been proposed (but none validated) and rely on a combination of variables and attendance figures.[7,86,87] In addition to understanding variables, event medical organizers should find generalized planning guides useful.[8] The variables that contribute significantly to mass gatherings medical care include weather and environmental factors, event type and duration, crowd mood, attendance and crowd density, age, and alcohol and drug use.

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