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# Mass-Gathering Medicine: A Review of the Evidence and Future Directions for Research

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## Abbreviations:

PPR = patient presentation rate  
TTHR = transport-to-hospital rate

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## Abstract

A review of mass-gathering medicine literature published by the Journal *Prehospital and Disaster Medicine*, demonstrates the progressive development of our knowledge and understanding of the health effects of mass gatherings and the strategies that appear to contribute positively to effective health services delivery during these events. In addition, the growing need for research that can underpin a more evidence-based approach to planning for and managing these events is apparent. The call for less descriptive and more critical and conceptual analyses has been increasing in volume and, it is argued, the challenge now is to apply research frameworks that can contribute more effectively to science-based, medical practice.

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## Introduction

Mass gatherings are characterized by large crowds of spectators and participants, and are an increasingly common feature of societies. These events are not well-understood and, surprisingly, are more hazardous than would be expected: they generate a higher incidence of injury and illness than is apparent from general population statistics even though they are collections of "well persons".<sup>1-3</sup> Furthermore, in recent years, there is increasing concern that mass gatherings may be subject to a catastrophic accident or attack resulting in large numbers of injured or dead persons.

For 22 years, *Prehospital and Disaster Medicine* has published academic papers that have contributed to the understanding of these complex events and continue to provide the underpinning for effective pre-event planning and resource provision. This paper provides an overview and introduction to key papers published by the Journal that have contributed to the understanding of the interplay between features of the mass-gathering phenomenon and the health impacts of these large gatherings on people and health services.

Milsten *et al* have provided an overview of the recent, mass-gathering literature and consider many of the important variables that can contribute to our knowledge of these events.<sup>4</sup> This literature has added to the understanding of individual events and has contributed to planning and the provision of health services during such events. However, much of the existing work is anecdotal or descriptive in character and is limited to the description of a single event or event type. It also is appropriate to consider more fundamental questions about the nature of these events and the causal relationships between features of the event and crowd health. It is appropriate to ask how current mass-gathering knowledge and understanding can be applied across different events. What concepts or models will help us to understand mass gatherings in ways that will contribute to the provision of appropriate services at new events or across different types of events? What influences and characteristics apply across all (or most) mass gatherings?

Several of the key features of mass gatherings that have been discussed in the literature<sup>4</sup> are well-recognized and considered important influences on the demand for health care during such events. These key characteristics

include: (1) the weather (temperature and humidity); (2) duration of the event; (3) whether the event is predominantly outdoors or indoors; (4) whether the crowd is predominantly seated or mobile within the venue; (5) if the event is bounded (fenced or contained) or unbounded; (6) the type of event; (7) the mood of the crowd, availability of alcohol and drugs; (8) the crowd density, the geography of the venue (or terrain/locale); and (9) the average age of the crowd. While this is not an exhaustive or complete list of the characteristics of mass gatherings that might be important in the development of our understandings about how these events work, it is clear that we are developing sufficient evidence to provide the underpinning for higher level analysis of mass gatherings and the development of conceptual models and theories.

### Landmark Papers

There have been several landmark papers published in *Prehospital and Disaster Medicine* that influenced the language, research approach, analysis, and conceptual thinking in the field of mass-gathering medicine research. Arguably, and noting my own possible bias, the following may be considered among this group of important papers.

In 1991, Hnatow and Gordon<sup>5</sup> provided a retrospective review of the San Antonio Papal Mass held in 1987. They began to apply a more critical approach to the analysis of mass gatherings. They were among the first to clearly articulate the purposes of the services that were provided, identified the lack of reliable tools for predicting presentation rates, noted that the environment of the event appeared to be a significant, though poorly understood, contributor to patient load, and utilized aerial photography to assist in estimating crowd size and staffing required for the event.

In 1997, Robert De Lorenzo published a literature review that assessed the state of scientific knowledge at that time, and challenged researchers to address key issues in the provision of an effective healthcare service during a mass gathering event.<sup>6</sup> In this review, De Lorenzo noted the lack of uniform standards for services, the wide variations apparent in casualty rates for similar events, and argued that a range of factors associated with the event including event type, weather, and differences in the data collection techniques employed were important causes of this wide variation.

In the same year, Michael and Barbera reviewed the provision of medical care at mass gatherings as described in 25 years of case reports.<sup>7</sup> Their research is a precursor study for the technique of systematic review that now is commonplace in healthcare research. Forty-seven events from 35 articles were used in the analysis. The findings demonstrated that the type of event, country, weather, and the size of the mass gathering had a significant effect on casualty presentations. In addition to providing an early analysis of the causative relationships between features of a mass gathering and the type and number of presentations seen by health services, the authors identified the need for a uniform classification scheme for future prospective studies.

Arbon, Bridgewater, and Smith have since reported on research on the influence of environmental factors (including crowd size, temperature, humidity, and venue type) on the number of patients and the patient problems present-

ing to first-aid services at mass gatherings in Australia.<sup>8</sup> Regression models were developed to predict rates of patient presentation and of transportation-to-hospital for future mass gatherings. Over a period of 12 months, 201 mass gatherings were included in the sample. They identified that several features of the event environment influence patient presentation rates, and that the estimation of patient load at these events is possible through the use of regression modeling and close attention to existing historical data. This project provided an exemplar for prospective study of the mass-gathering environment.

In 2002, Milsten *et al*<sup>4</sup> provided an extensive literature review using searches of Medline and Healthstar from 1997 to May 2002, in effect taking stock of progress over the five-year period since the De Lorenzo<sup>6</sup> and Michael and Barbera<sup>7</sup> reviews. The paper revisits and reviews the multiple, interacting variables that add an element of uncertainty to planning for mass gatherings and argues that an improved understanding of these variables could improve event planning. Not surprisingly, key variables identified in this review are weather and environmental factors, event type and duration, crowd mood, attendance and crowd density, age, and alcohol and drug use. This paper provides a good overview and starting point for anyone contemplating research or service provision during a mass-gathering event. It challenges us all to consider the interaction and/or cumulative effects of the key features of mass gatherings that may influence the number and type of patients who will require health care.

In 2004, Arbon noted the preponderance of descriptive papers in the literature and argued for more critical work including the development of middle-level theory and conceptual models to encourage greater levels of research in the field of mass-gathering medicine.<sup>9</sup> Two beginning conceptual models were presented as a means to encourage further debate about the dominant influences on the health of people where crowds gather and to promote less superficial forms of interpretation of the research data. These conceptual models are based on the idea that mass-gathering health can be understood as an inter-relationship between three domains: (1) biomedical; (2) environmental; and (3) psychosocial. Each domain is characterized by key features that will influence the rate of injuries and illnesses. These key features are understood for the most part, and combine to produce an effect, the patient presentation rate, and a response to be included in the health plan for an event.

### Definition of a Mass Gathering

There does not appear to be consensus on a definition of a mass gathering, although most researchers have defined mass gatherings in terms of the number of people attending the event. Some argue that a mass gathering is an event attended by >1,000 persons and others argue for >25,000. However, these definitions are limited because they only consider the size of the crowd and, therefore, are based on a single characteristic of the event (i.e., the number of people attending) rather than on a broader understanding of the phenomenon. For example, a more appropriate definition might incorporate the idea that a mass gathering is a situation (event) during which crowds gather and where

there is the potential for a delayed response to emergencies because of limited access to patients or other features of the environment and location. This potential delay requires planning and preparation to limit (or mitigate) the hazards inherent in a mass gathering and ensure timely access to appropriate health care is available.

This broader definition of a mass gathering may be useful for two reasons. First, it recognizes that planning for and the delivery of health services during mass gatherings is complicated by the context and situation in which the care will be provided. Second, it provides a definition that incorporates “non-traditional” mass gatherings as well as the more traditional large public events. Of course, there are other situations apart from public events in which crowds are gathered together and access and management of emergencies is complicated by the environment and the crowd. These “non traditional” mass gatherings have not been well-researched and include metropolitan subway systems, large shopping complexes, airports, cruise ships, public demonstrations, refugee camps, and the like. From a health perspective, it is likely that similar key features influence patient presentations in these situations. Some of the principles for the provision of health services highlighted in the mass-gathering literature may be applied to these non-traditional mass gatherings and inform the approach to planning and preparation for the delivery of health care in these environments.

#### Purposes of Mass-Gathering Medical Services

There appears to be agreement on the principal goals of mass-gathering medical care. These goals include: (1) establishing rapid access to the injured or ill patients, and providing triage; (2) effectively and timely stabilizing and transporting seriously injured or acutely ill patients; and (3) providing on-site care for minor injuries and illnesses.<sup>5,6</sup> The decision to provide on-site care for minor problems is complex, and De Lorenzo argues that the services provided should reflect the needs of patrons and the desires of event sponsors.<sup>6</sup> Confounding factors include those events with large a geographic spread, a captive audience, and/or a local hospital system that could be overloaded.<sup>6</sup>

#### Evidence-Based Practice and Uniform Standards

There is a lack of uniform standards for the provision of health services at mass gatherings.<sup>6</sup> Mass-gathering medicine is founded on relatively low levels of evidence. The absence of theory and common research frameworks and definitions contributed to considerable variations in the standards applied within mass-gathering health guidelines and legislation. There is an over-reliance on the “expert level of evidence”. Donagen has highlighted this issue in his review of the level of evidence supporting event guidelines in several countries.<sup>10</sup>

#### Research Development

Generally, it is agreed that descriptive papers that focus on a single event or event type dominate the literature. While these papers contribute to the understanding of the patient care that may be required at events, they do not provide an

adequate analysis of the health effects of the mass-gathering phenomenon itself. As early as 1991, Hnatow and Gordon noted the “profound” effect of the environment of a mass gathering on the numbers and type of injuries or illnesses that will present to the health service.<sup>5</sup> They commented that no reliable method existed to predict how many patients might be expected. In this early paper, the authors recognized the need to analyze these events more rigorously and to develop explanatory models that could assist planners and service providers.

This research work would benefit from acceptance of common definitions for research data points. Mass-gathering health research is at a relatively early stage in its development, and many of the terms and concepts used only have been poorly defined or are relatively new. Mass gathering health research would be aided by the development of greater consensus particularly with respect to the collection of data. The transport-to-hospital rate (TTHR) and patient presentation rate (PPR) are examples of an emerging common language.<sup>6-8,11</sup> The issues in the current development of mass-gathering health research are summarized in Table 1.

The lack of a consistent approach to the collection of data is one of the impediments to the development of theory in mass-gathering research. A review of the literature suggests that mass-gathering health research is characterized by an excess of isolated studies that are not linked to an integrated theoretical framework, and, subsequently, there are deficiencies in the theoretical basis to support and guide practice.

#### Profile of Casualty Types and Range of Severity/Acuity of Presentations

The profile of casualty types and range of severity or acuity of presentations is highly consistent when the key features influencing rate and type of presentation have been taken into account. Respiratory illnesses, minor injuries, heat-related injuries, and minor problems (headache, blisters, sunburn) make up 80% of the casualties. In Australia, for example, of patients requiring acute interventions, asthma attacks (3%) are the most common complaints.<sup>8</sup> Outdoor events produce more environmentally related injuries such as lacerations and sunburn. Events attracting young people, such as rock concerts, produce more alcohol and drug abuse-related problems. Cardiac arrests occur infrequently—Wassertheil *et al* have shown (1:500,000 at Australian Rules football events) though on-site resuscitation and early defibrillation are important and can improve patient survival rates.<sup>12</sup> Broadly speaking, these presentation types are similar across countries and commonly reported in the international literature. Differences that do occur appear to be associated more closely with key features of events, such as weather and the nature of the activity.

However, the range of total PPR and TTHR for similar events is significant (up to 60 fold). While this finding underpins the argument that more attention should be focused on understanding the factors that affect the PPR and TTHR, it also is argued that different data collection strategies and analyses affect this difference.

1. Differences in data collection and reporting formats appear to have influenced the wide variation observed in PPR across events described in the literature;
2. Terminology and concepts utilized in the literature are not well-defined or used in a consistent fashion;
3. Research questions often are poorly developed and fundamental concepts and methods are not explained well;
4. There is no common understanding of the definition of a mass gathering though generally the definition is based on the size of the crowd; this limits our understanding of these situations;
5. There is a need for the development of greater consensus particularly with respect to the collection of data; and
6. Current knowledge, because it lacks theory development and adequate conceptual analysis, fails to adequately inform our understanding of mass gatherings.

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**Table 1**—Current issues in the development of mass-gathering health research (PPR = patient presentation rate)

### Researching the Challenge to Health Status

The health challenges that arise during mass gatherings must be investigated. Some thought must be given to the treatment of causation (prevention or mitigation). Therefore, investigators must consider other novel features of events and apply new criteria within their research. Examples include consideration of crowd activity, including the mobility of the crowd, crowd density, if the venues are bounded, and if the audience is captive.<sup>6,8</sup>

Much work must be done, but progress continues as researchers consider events in a more scientific manner. Examples of new concepts emerging from the literature include: (1) assessment of the difference between In-and-Out PPR; (2) analysis of the influence of ease of access on crowd health;<sup>11</sup> (3) increased emphasis on real-time, “presenting problem” surveillance; and (4) a focus on providing as much of the “Chain of Survival” as possible within the event site.<sup>13</sup>

### Predictive (Generic) and Historical Models

Planners for the provision of health care at mass gatherings have access to methods that can estimate the number of patient presentations. The Arbon *et al* method is useful particularly for events for which there is no or limited information about previous medical work (e.g., one-time, special events).<sup>8</sup> It provides a broad prediction based on the combination of information gathered from a range of events. This prediction has proven to be accurate over the entirety of the event, but is limited in its ability to predict inter-day variability. Retrospective (historical) reviews of data generated from a specific event considers the unique and individual variability that can occur from event-to-event, and is more accurate for predicting patient presentations when the data are available.<sup>14</sup> The two methods can be considered complementary in more accurately determining medical work during public events, though it should be noted that these models have not been validated in other countries or across a wide range of environmental

conditions. While the methods do not incorporate the level of medical assistance required (i.e., skill levels of medical service), both can be used to support planning for events.

The debate over the level and extent of staffing for events has continued for more than a decade. There has been some shift away from the idea that physician involvement (on-site) is essential.<sup>15</sup> Additionally, the capacity of nurses, paramedics, and those with advanced first-aid skills to manage and stabilize patients has grown. Still, skill mix and workload modeling lacks a strong research-evidence foundation. It has been argued that workload should be considered in the form of person attendance hours rather than attendance number to arrive at patient visit frequency<sup>7</sup> and ability to meet evidence-based response time targets (operational modeling) should be a goal.

### Future Challenges for Research

Future challenges for researchers and practitioners in the field of mass-gathering medicine include:

1. *Focus on vulnerable populations*—Including the elderly, children, and those for whom the risk of harm is associated with the location of the mass gathering;<sup>16</sup>
2. *Efforts to promote prevention and/or mitigation of the health effects of mass gatherings*—Reducing the minor injury or illness workload through prevention and mitigation and the flow on effect of workload reduction on on-site health service capacity;
3. The adoption of standard terms and definitions and data points and a research framework to facilitate comparisons and possible systematic reviews and meta-analysis of findings;
4. Research in non-traditional mass gatherings and unexpected mass gatherings and analysis of key issues;<sup>17</sup>
5. *Assessment of the potential for disaster or catastrophic emergency involving mass gatherings*—What can be learned from mass-gathering medicine to contribute to providing a health service for displaced populations in evacuation and refugee settings and for disaster-affected individuals—to what extent can we predict the impact of a catastrophic emergency at a mass gathering venue?; and
6. Assessing workload, patient flow, and outcomes utilizing frameworks existing in-hospital management research.

### Summary

A review of the mass-gathering medicine literature published by *Prehospital and Disaster Medicine* demonstrates the progressive development of the knowledge and understanding of the health effects of mass gatherings and the strategies that appear to contribute positively to effective health services delivery at these events. In addition, the growing need for research that can underpin a more evidence-based approach to managing these events is apparent. The call for less descriptive and more critical and conceptual analyses has been increasing in volume, and the challenge now is to apply research frameworks that more effectively can contribute to evidence-based medical practice.

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