ORIGINAL RESEARCH

The Development of Conceptual Models for Mass-Gathering Health

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Abbreviations:
MUR = medical usage rate
PPR = patient presentation rate
THR = transport to hospital rate

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Abstract

Mass gatherings are an increasingly common feature of modern society. However, descriptive papers that focus on a single event or event type, dominate the literature, and, while these contribute to our understanding of the patient care required at such events, they do not provide an adequate analysis of the health effects of the mass-gathering phenomenon itself. This paper argues for the development of conceptual models and a research template for mass-gathering research. The development of theory and conceptual models would promote a better understanding of the health effects of mass gatherings. Two preliminary conceptual models are 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 analysis 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) the biomedical; (2) the environmental; and (3) the psychosocial. Key features influence the rate of injury and illness and characterize each domain. These key features are more or less well-understood and combine to produce an effect—the patient presentation rate, and a response—the health plan. A new element, the latent potential for injury and illness, is introduced as a mechanism for describing a biomedical precursor state important in assessing health risk during mass gatherings.

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Introduction

Mass gatherings attended by large crowds of spectators and participants are an increasingly common feature of society. These events are not well-understood and surprisingly, are more hazardous than would be expected as they generate a higher incidence of injury and illness than occur in the general population, even though they generally are collections of "well persons".[1–3] Research has provided a better understanding of the influences on patient presentations at mass gatherings and underpins more effective pre-event planning and resource provision.[4] However, there is a need for more theoretical and conceptual analyses of these complex events.

Milsten *et al* have provided an overview of the recent mass-gathering literature and have considered many of the important variables that can contribute to our understanding of these events.[5] This literature has added to our understanding of individual events and contributed to the planning and provision of health services. 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 now is appropriate to consider more fundamental questions about the nature of these events and the causal relationships

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 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 and this is limiting 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.

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

between features of the event and crowd health. It is appropriate to ask how current knowledge and understanding about mass gatherings 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 medical services at new events or across different types of events? What concepts, influences, and characteristics apply across all (or most) mass gatherings?

Several of the key features of mass gatherings have been discussed in the literature and five are well-recognized and considered important influences on the demand for health care. Patient presentation rates for individual events or event types frequently are reported and provide a fundamental measurement of both the risk of injury or illness at an event and the level (and extent) of healthcare services that may be required. The rate of patient presentation also is referred to as the Medical Usage Rate (MUR), though this term may be limited in some studies to presentations to medical services and exclude first-aid and other prehospital care presentations. Reported Patient Presentation Rates (patients presenting per 1,000 spectators—PPR) vary significantly ranging from 0.14 to 90/1,000; though most reported events have ranged between 0.5 and 2.6/1,000.[6] The range of PPRs reported reflects significant variation across events in the key features (such as weather, event type, availability of alcohol) that is known to influence the number and type of patient problems that present to healthcare services. However, the extent to which differences in data collection and reporting formats for studies reported have influenced the variation in reported PPR is unknown, but is clearly an issue.

More recently, research by Arbon *et al* has considered transport rate (by ambulance) from the event first-aid service to local hospitals as a useful additional piece of information for event planning.[4] This rate has been referred to as the Transport-to-Hospital Rate (TTHR) and, in Arbon *et al*, on average, was 0.027/1,000 in attendance at an event.[4] Previously, the TTHR has ranged from 0.01 to 0.55/1,000 and, once again, it is not clear to what extent this variation is due to differences in data collection and reporting formats used across the studies.[6]

Discussion

Comparison of research findings and the development of theory

The mass-gathering literature demonstrates that several key characteristics of an event have an effect on the PPR and influence the decisions that we make when planning for the provision of health services.[5] These key characteristics include: (1) the weather (temperature and humidity); (2) duration of the event; (3) whether the event is predominantly an outdoor or indoor event; (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 crowd mood; (8) availability of alcohol and drugs; (9) the crowd density; (10) the geography of the event (or terrain/locale); and (11) 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 understanding of how these events work, it is clear that sufficient evidence is being developed to provide the underpinning for higher level analysis of mass gatherings and the development of conceptual models and theories.

Several researchers have attempted to develop models that explain how the key characteristics influencing patient presentations might interact with one another.[4,7,8] These studies are important because they have begun to model the complex interactions between the key characteristics of mass gatherings. There are causal relationships between the features of a mass gathering and the number and type of injuries and illnesses that present to healthcare services.

Mass-gathering models are limited in scope because it is difficult to compare and build on previous work. This difficulty arises from the fact that we have not given due consideration to the terminology and concepts that should underpin such research. For example, each of the key characteristics of mass gatherings has been described in various ways. Comparison of events would be facilitated if common definitions and approaches to data collection could be developed. For example, common categories for patient presentations (illness and injury groups) would facilitate sharing of data and comparison across events.

Many questions remain poorly developed and fundamental concepts are not well-explained by researchers and authors. For example, what patients are counted in the research data for an event? Are the data limited to patients presenting for medical care or extended to include patients presenting to first-aid services or exiting the event and attending local or regional hospitals? Some data collections have incorporated all patients presenting within the region who have been managed by the health services tasked to an event; for example, a street parade, regardless of whether or not the injury was associated with the event. In this instance, a local resident injured at home, but within the vicinity of the event might find himself or herself counted as a casualty arising from the mass gathering. This variance in the data collection "rules" limits our ability to compare across studies and to draw more general conclusions.

Further, it is not clear what we mean by the term "mass gathering". There does not appear to be a consistent definition, although most researchers define a mass gathering as an event attended by a "large number of people"; some

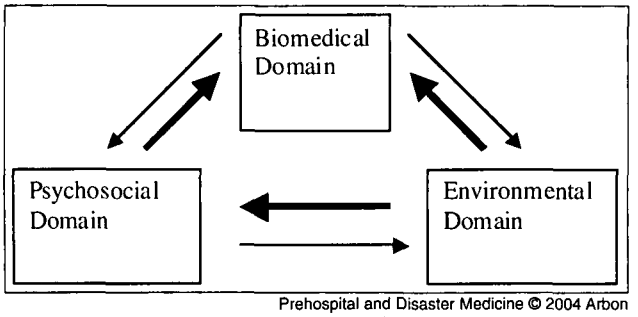

Figure 1—A relationship model of domains for mass-gathering health (*Relative strength of influence indicated by weights of arrows*)

argue for >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 or event during which crowds gather and where there is the potential for a delayed response to emergencies because of limited access or other features of the environment and location. This "potential" delay requires planning and preparation to limit (or mitigate against) the risks associated with the mass gathering and should ensure timely and appropriate health care is available.

This broader definition of a mass gathering may be useful for two reasons. First, it recognizes that the planning for and the delivery of health services during mass gatherings is complicated by the context and situation in which the medical care will be provided. Secondly, 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 gather and in which 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. To this extent, 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 our approach to planning and preparation for health care in these environments in the future.

These examples suggest that mass-gathering health research is at a relatively early stage in its development and that many of the terms and concepts are poorly defined or relatively new. Mass-gathering health research would be aided by the development of greater consensus particularly with respect to the collection of data. These issues in the current development of mass-gathering health research are summarized in Table 1. The World Association for Disaster and Emergency Medicine (WADEM) recently published its *Health Disaster Management Guidelines for Evaluation and Research in the Utstein Style.*[9] This publication provides a guide to researchers and promotes the collection of data and the discussion of results within a common framework or template. Although this work relates specifically to health research in disasters, it provides an example of the benefits of using common frameworks when researchers are dealing with complex emergencies. Mass gatherings also are complex systems and a common (agreed upon) set of definitions and data points would greatly assist researchers in extending their analysis beyond a single event and into the further development of our understanding of mass-gatherings wherever they occur. 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 integrating theoretical framework and, subsequently, a deficient theoretical basis to support and guide practice.

The absence of theory and common research frameworks and definitions appears to have resulted in considerable variation in the standards applied within mass-gathering health guidelines and legislation and an over-reliance on the expert level of evidence. Donegan has highlighted this issue in his recent review of the level of evidence supporting event guidelines in several countries.[10]

Conceptual model for mass-gathering health care

It is useful to develop conceptual frameworks that can be employed to improve our understanding of mass gatherings across events. A conceptual model for mass-gathering health care should refer to the key characteristics of mass gatherings and provide a structure for organizing and linking these features. A conceptual model can act as a heuristic device and lead to the development of better understandings about the phenomenon (i.e., mass gatherings) itself rather than simply a single event with its own natural differences and peculiarities. It is important to take this perspective because currently, too much work allows for understanding of a single event, and too little can be usefully applied to new or different events. In a similar fashion, current knowledge, because it lacks theory development and adequate conceptual analysis, fails to inform the understanding of non-traditional mass gatherings, such as subway systems, large shopping complexes, airports, where access to emergency medical care may be delayed by the nature of the venue and the size of the crowd.

As noted previously, a number of concepts, influences, and characteristics of mass gatherings have been identified in the literature, and these may be used to begin to develop conceptual frameworks and theory. The preliminary models proposed here divide the key characteristics of mass-gathering events into three inter-related domains: (1) biomedical; (2) psychosocial; and (3) environmental. The models are unsophisticated and simply intended to generate further discussion about the development of theoretical frameworks for mass-gathering health. The Biomedical Domain is concerned with understanding the biomedical influences on the number and type of patients

Psychosocial domain	*Biomedical domain*	*Environmental domain*
Crowd: a. behavior b. mood	Crowd and individual health status	Crowd: a. attendance b. density
Individual: a. motivation b. behavior	Latent potential for illness and injury	Venue: a. bounded/unbounded b. extended/focused c. locale/terrain
⇐	⇒ ⇐	⇒
Crowd interests/ morays/ culture	Crowd average age/ gender	Type/ nature of event
⇐	⇒ ⇐	⇒
Rationale/ reason for attendance	Activity level (participant/ spectator)	Predominantly seated or mobile
⇐	⇒ ⇐	⇒
Length of stay	Heat- or cold-related physiology	Outdoor or indoor weather (temperature/humidity)
⇐	⇒ ⇐	⇒
Use of alcohol or drugs	Alcohol- or drug-related physiology	Availability of alcohol or drugs
	⇩	⇩

Effect	**Response**
Risk of injury or illness: a. Patient presentation rate (PPR) b. Transport to hospital rate (TTHR)	Level and extent of healthcare services

Figure 2—A proximity model for mass-gathering health care; the arrows indicate interactions between domains; key characteristics are shown and those adjacent in each domain have the strongest relationships

that might present at a mass gathering. The Psychosocial Domain captures the psychological and social influences within mass gatherings including individual and crowd (or mass) behavior and motivation. The Environmental Domain incorporates the environmental features of a mass gathering including the weather and terrain. Each domain will interact with the others and produce effects that can be measured in patient presentations and types of illness and injury.

Similarly, the domains will interact to produce a response that results from planning and leads to a health response strategy designed to meet the specific needs of the mass gathering (Figure 1), a Relationship Model, proposes the relative strength of influence between these mass-gathering health domains. For example, in this model, it is proposed that features of the environmental domain, such as ease of access and crowd density, have a relatively strong influence on features of the Psychosocial Domain, such as crowd mood and behavior, and, in a similar fashion, also have a relatively strong effect on the (latent) potential for injury or illness within the biomedical domain. A densely packed crowd with poor access to an event (Environmental Domain) will be more frustrated (Psychosocial Domain) and be inclined to be violent. Both of these effects will increase the latent potential for injury and illness (Biomedical Domain). Features of the Psychosocial Domain, such as crowd mood, will have a relatively less significant effect on the environmental domain.

Within the Proximity Model in Figure 2, the arrows indicate the interaction between the domains, key characteristics within each domain are listed, and the relationships between key characteristics are considered to be stronger and more clearly demonstrated where features are adjacent to one another in the model. For example, the relationships between use of alcohol or drugs (Psychosocial Domain), alcohol or drug-related physiology (Biomedical Domain), and the availability of alcohol or drugs within the venue (Environmental Domain) are quite strong, and these characteristics appear adjacent to one another. Note that each domain, including the Biomedical Domain, is concerned with key characteristics that may contribute to the incidence of illness and injury.

The proposed relationships are based on existing evidence about the key characteristics of mass gatherings drawn from the literature. This paper will not review in detail the existing research that underpins the choice of the characteristics listed in the model. However, Milsten *et al* provide a good overview of the research support for the choices that have been made and applied to this model.[5]

Several of the key characteristics incorporated into the Proximity Model have been researched extensively, and there is strong evidence for the relationships between these elements and the PPR. These include: (1) the effect of the type of event; (2) crowd size; and (3) weather conditions on PPR. Other features have not been well-researched. For example, crowd mood frequently is identified as a feature, but its effect on crowd health is not understood. Other key characteristics are hypothetical and included to stimulate further research and discussion. For example, the model incorporates the idea that an element of the Biomedical Domain could be described as the latent potential for injury or illness and associated with the context and situation of the event.

More analytical and conceptual analyses will assist in the development of theoretical frameworks and a better understanding of the epidemiology of mass gatherings. The models proposed above can be used to plan interventions to deal with predicted patient problems for an event.

A two-layered analysis is necessary, which reflects the commonly used approach that incorporates pre-event analysis and the development of an event plan. First, a review of the characteristics of the event should be undertaken and compared against each of the features identified in the model. For example, what kind of activity is proposed? What age will the crowd be? Will they be participants or spectators? What weather conditions are forecast? This first cut will identify key factors that need to be addressed in planning and developing a profile for the event in each domain. For example, it might be considered likely that there will be a problem with the availability of alcohol or other drugs at the event and subsequent injury and intoxication.

Then, the model can be used to consider health interventions within each domain. In the case of a predicted alcohol or drug problem, several strategies could be developed. Within the Psychosocial Domain, preventive strategies aimed at encouraging sensible consumption of alcohol and safe drug use could be introduced as part of pre-event advertising or at entry points to the event. These interventions should consider other key factors within the Psychosocial Domain including crowd interests/morays and culture, so that interventions are suitable and targeted at this psychosocial profile. In the Biomedical Domain, steps could be taken to ensure that treatment stations are staffed adequately and equipped to manage potential alcohol or drug-related injury or illness. The average age of the crowd is a key characteristic in this domain that might influence the type of drug or alcohol use at the event. And finally, in the Environmental Domain, strategies could be developed to limit or reduce the consumption of alcohol and other drug use. This might include, in the case of alcohol, bag searches on entry and confiscation of alcohol, low alcohol content beverages only sold within the venue, limits on the amount of alcohol that can be purchased in any one sale at venue bars and restaurants, and the introduction of plastic cups instead of more (potentially) dangerous beverage containers such as aluminum cans and bottles. In each case, the interventions developed should be domain specific—they should be designed to address elements within a specific domain and to accommodate the particular profile of that domain for the event.

The models presented here can be used to test theory because they represent assumptions drawn from existing research that must be tested further. For example, the strength of the relationship between causal features of an event can be further tested and new relationships identified. One possible outcome might be the development of formulae to assist in the assessment of the latent potential for injury and illness. Assessment of this key element would complement existing models for the prediction of the PPR and TTHR and underpin risk management strategies developed for mass-gathering situations.[4]

Conclusions

Current mass-gathering health literature is characterized by the dominance of anecdotal and descriptive accounts. Recent work by Milsten *et al* has provided a useful overview of the key elements that influence crowd health at mass gatherings.[5] It is clear that there are causal relationships between the characteristics of a mass gathering and injury and illness rates. Several researchers have developed predictive models that employ these relationships to provide information about the possible PPR and TTHR for mass-gathering events.

Mass-gathering health research is at a relatively early stage in its development and principal terms and concepts must be defined more clearly. An excess of isolated studies not linked by a theoretical framework characterizes current research. This paper outlines a beginning attempt to overcome this shortcoming and proposes two conceptual models that provide insight into the relationships between the key features of mass gatherings and the basis for future theory development and research.

Conceptual models assist in the development of theory. However, this is a higher-level activity that underpins the development of research and contributes to the evidence base that we use in formulating event guidelines and other, more applied tools that assist event planners and healthcare providers. Therefore, the models presented here are not intended to replace mass-gathering guidelines, but rather to encourage further research focused on the mass-gathering phenomenon itself and to facilitate the development of the knowledge base that we apply to our practice. In the future, strategies that will assist researchers in developing common research frameworks and definitions should be considered, so that their work can contribute more directly to the body of knowledge that we are developing in this area.

References

1. Franaszek J: Medical care at mass-gatherings. *Ann Emerg Med* 1986; 15(5):600–601.
2. Parrillo S: EMS and mass-gatherings. *emedicine Website*. Available at emedicine.com/emerg/topic812.html. Accessed 15 January 2003.
3. Thompson JM, Savoia G, Powell G, *et al*: Level of medical care required for mass gatherings. The XV Winter Olympic Games in Calgary, Canada. *Ann Emerg Med* 1991;20(4):385–390.
4. Arbon P, Bridgewater FHG, Smith C: Mass-gathering medicine: A predictive model for patient presentation rates. *Prehosp Disast Med* 2001;16(3): 109–116.
5. Milsten AM, Maguire BJ, Bissell RA, *et al*: Mass-gathering medical care: A review of the literature. *Prehosp Disast Med* 2002;17(3):151–162.
6. De Lorenzo RA: Mass-gathering medicine: A review. *Prehosp Disast Med* 1997;12(1):68–72.
7. Arbon P: The development of a web-based algorithm for the prediction of patient presentation rates at mass-gatherings. *Australian Journal of Emergency Management* 2002;17(1):60–64.
8. Flabouris A, Bridgewater FHG: An analysis of demand for first-aid care at a major public event. *Prehosp Disast Med* 1996;11:48–51.
9. WADEM: Health disaster management: Guidelines for evaluation and research in the Utstein Style. *Prehosp Disast Med* 2003;17:Supplement 3.
10. Donegan D: Mass-gathering medicine: A critical review. Available at www.emermanconsulting.com. Accessed 15 December 2000.