

Conceptualizing the Impact of Special Events on Community Health Service Levels: An Operational Analysis

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Abbreviations:

ED: emergency department
EMS: Emergency Medical Services
MCI: mass-casualty incident
MG: mass gatherings
MGH: mass-gathering health
MGMIG: Mass-gathering Medicine Interest Group

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Abstract

Mass gatherings (MG) impact their host and surrounding communities and with inadequate planning, may impair baseline emergency health services. Mass gatherings do not occur in a vacuum; they have both consumptive and disruptive effects that extend beyond the event itself. Mass gatherings occur in real geographic locations that include not only the event site, but also the surrounding neighborhoods and communities. In addition, the impact of small, medium, or large special events may be felt for days, or even months, prior to and following the actual events. Current MG reports tend to focus on the events themselves during published event dates and may underestimate the full impact of a given MG on its host community.

In order to account for, and mitigate, the full effects of MGs on community health services, researchers would benefit from a common model of community impact. Using an operations lens, two concepts are presented, the “vortex” and the “ripple,” as metaphors and a theoretical model for exploring the broader impact of MGs on host communities. Special events and MGs impact host communities by drawing upon resources (vortex) and by disrupting normal, baseline services (ripple). These effects are felt with diminishing impact as one moves geographically further from the event center, and can be felt before, during, and after the event dates. Well executed medical and safety plans for events with appropriate, comprehensive risk assessments and stakeholder engagement have the best chance of ameliorating the potential negative impact of MGs on communities.

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Introduction

Mass gatherings (MG) impact their host and surrounding communities and with inadequate planning, may impair baseline emergency health services. Mass gatherings do not occur in a vacuum; they have both consumptive and disruptive effects that extend beyond the event itself, both geographically and over time. Mass gatherings occur in real geographic locations that include not only the event site, but also the surrounding neighborhoods and communities.¹ In addition, the impact of a small, medium, or large special event may be felt for days, or even months, prior to and following, the actual events. Current MG reports tend to focus on the events themselves during published event dates, at times underestimating the full impact of a given MG.

In order to account for, and mitigate, the full effects of MGs on community health services, researchers would benefit from a common model of community impact. Using an operations lens, two concepts are presented, the “vortex” and the “ripple,” as metaphors and a theoretical model for exploring the broader impact of MGs on host communities. Special events and MGs impact host communities by drawing upon resources (vortex), and by disrupting some normal, baseline services and community functions (ripple). Well-executed medical and safety plans for events with appropriate, comprehensive risk assessments and stakeholder engagement have the best chance of ameliorating the potential negative impact of MGs on communities.

The Problem—Conceptualizing Community Impact

Although many stakeholders are invested in the successful running of events in their communities, there is no universal obligation to consider the impact of events on health or general community service levels.

The case example presented in Figure 1, while not exhaustive, identifies many of the stakeholders involved and captures the scope of community impacts of a large MG. The purpose of this report is to introduce a model that will be useful to community stakeholders in predicting and understanding potential impacts of a MG on their baseline community health services.

Background

Mass gatherings, or special events, draw together thousands of people for community activities such as sporting events, cultural festivals, parades, and political or religious gatherings. A growing body of MG literature defines MGs in various ways, often in terms of the number of persons gathered. More contemporary definitions have moved away from numerical definitions, and increasingly reflect an event's potential impact on a community and its response capacity. For example, the World Health Organization definition acknowledges the relationship between the size of the community and the scale of the event, when MGs are described as organized, special event(s) in which the number of people in attendance strains or overwhelms the planning and response resources of the community/state/nation hosting the event.²

Building on earlier work,³ Arbon et al noted that published MG literature, to date, consists predominantly of observational studies and cohort studies (>58%), most commonly focused on operations and Emergency Medical Services (EMS) on site at the event (>48%).⁴ Case reports and case series provide snapshots of specific events, commonly reporting patient presentations and transfers to hospital on the day(s) the event occurred. Unfortunately, these reports will underestimate the true impact of special events on local community resources; such reports ignore the geographic and temporal nuances associated with events. Snapshot case-reporting has several weaknesses, including failure to capture the full range of casualties (eg, not recording individuals who call ambulances on their own, or attend medical services in the community as a “walk-in,” or who later seek care in other communities).^{5,6} As well, case reports rarely capture data regarding increased workload on health resources in the days or hours before and/or after the event. Ideally, a full operational analysis would account for both the consumptive and disruptive effects of MGs in order to describe the full impact on the host community(ies).

Conceptualizing the Community Impact of Mass Gatherings—Two Metaphors

Conceptualizations of the vortex effect (Figure 2) and the ripple effect (Figure 3) emerged from ongoing research by the members of the Mass-gathering Medicine Interest Group (MGMIG) in Vancouver, British Columbia (Canada).⁷ An initial focus of the MGMIG's research has been on medical capacity and operations at small, medium, and large-sized events. One area of interest for the group is the relationship between medical operations at MGs and the impact these events have on the broader community, in particular on EMS (eg, ambulance and paramedic services) and emergency departments (EDs). While exploring methods for measuring the impact of MGs on the broader community, it was

noted that MGs tend to draw upon local resources and also create effects that extend past the immediate event itself, in effect, consuming locally available resources. These trends were again noted with more thorough review of literature on public health and safety within the context of MGs. Finally, recent work in reviewing literature related to mass-casualty incidents (MCIs) in MG contexts provided further examples of the potential impact of MG events on communities outside the immediate context of the event itself.¹

The Vortex Effect

A vortex is an aquatic metaphor representing the whirlpool that forms above a drain, drawing water (and anything in the water) towards the center. In the context of MGs, the vortex effect helps to explore the consumption of health resources for the host and surrounding communities. These effects can be observed before, during, and after an event (temporal effects), and are felt with decreasing power at greater distances from the event (geographic effects). The vortex effect is seen when baseline community health care resources are diverted toward meeting the needs of the population attending an event. The vortex may take the form of supporting overwhelmed onsite health services, supplementing health care resources that are part of the event, or responding to a MCI. Health care resource redistribution, human resource shortages, and prolonged emergency response or wait times are three key issues that may arise as a result of the vortex effect.

Health Care Resource Redistribution

In terms of health care resource redistribution, suppose a MG generates a disproportionate number of patients requiring ambulance transport. In many Canadian jurisdictions, as few as five or six ambulance calls to a single event site in a short period of time can cause a cascade of service disruptions. Ambulances are drawn to the event, draining the host community of its baseline services. Other ambulances are therefore seconded from surrounding communities to provide cross coverage during the surge, depleting resources from adjacent communities. In its most extreme form, the vortex effect may become overwhelming when a MG event becomes the site of an MCI.

Human Resource Distribution

Mass gatherings require dedicated human and supply resources, which may result in operational shortages. Consider the following four examples:

1. Many ambulance services have to deploy dedicated equipment and teams, such as bike squads or gator teams, known in British Columbia as “Special Operations.”⁸
2. Local service(s) may be seconded to act as part of a planned response for the event, in which case personnel, equipment, and resources are withdrawn or redistributed from standard operational capacity.
3. The event may contract off-duty personnel and use surplus or nonscheduled ambulances to reduce the impact on baseline operations. The event may not directly impact the baseline operational service, but if scheduled staff becomes ill or injured, or operational units malfunction, the system now has reduced overall capacity or reserve to compensate.
4. Finally, in small and large communities, acute care services may be forced to extend the hours of operation. For example, during the 2013 and 2014 Ironman-Canada in

A city council in a medium-sized North American city received a permit request for a concert and fireworks festival to be held in celebration of a national holiday. After much discussion and debate, the council approved the permit. City planners, by-law enforcement personnel, police, the fire chief, the ambulance service, maintenance officials, and event planners, began a series of meetings.

Each group had a specific organizational agenda.

- **City Planners** wanted to mitigate traffic disruption through the city as the event was expected to attract over 100,000 people.
- **Maintenance Officials** were concerned about the sheer volume of waste created by a large crowd.
- **Police** were worried about crowd behavior given the likelihood of substance use and the crowd that the popular main-stage performers were likely to attract, and wanted to review and work with the event organizer's contracted security providers.
- **By-law Enforcement** wanted to ensure that no laws were broken during the event; specifically, the municipal government did not want people consuming alcohol in the park.
- **Traffic Enforcement** was concerned with vehicular movements and parking in, out, and throughout the city.
- **Fire Services** wanted to ensure safe handling of fireworks, and ensure access and egress of vehicles and fire suppression equipment for fire-related emergencies.
- **Ambulance Officials** wanted to ensure adequate standby coverage for the expected extra "calls," and to ensure that baseline services in the community were preserved for citizens not participating in the event.
- **Event Producers** wanted to create a safe, profitable mass gathering, and so on.

Of note, no person or group on the list of people engaged in these meetings was responsible for predicting or measuring the impact of the special event on the overall health service levels for the surrounding community. Representatives from the local hospital and health authority were not invited to the planning table. In addition, no one was specifically responsible for planning should a mass-casualty incident occur.

The event itself^a ran relatively smoothly and was generally considered a success. Yet, the event had a significant impact on the community.

- The week before the event, a truck carrying fireworks to the site exploded, damaging a section of the overpass above, requiring indefinite road closures and traffic rerouting.
- 175,000 people attended the event, almost double the initial expectation, leading to:
 - 237 logged security incidents
 - 34 arrests by the police related to assaults and disorderly behavior
 - 398 patients attended to by on-site volunteer first aid service providers
 - 22 people who required transport to local emergency departments with acute alcohol and/or drug intoxication
 - 10 patients who were transported to local emergency departments for suturing, three for suspected fractures, two for stab wounds, and five for head injuries associated with assaults
 - In the 72 hours following the event, a wave of casualties presented to local emergency departments with symptoms of food poisoning. Numerous media reports cite hundreds of work absentees attributed to gastrointestinal distress, which eventually were tracked back to a "taco stand" at the fireworks
 - Response times for ambulance calls in the community increased by 275%, with at least one call for chest pain that took 47 minutes to get a crew on scene.

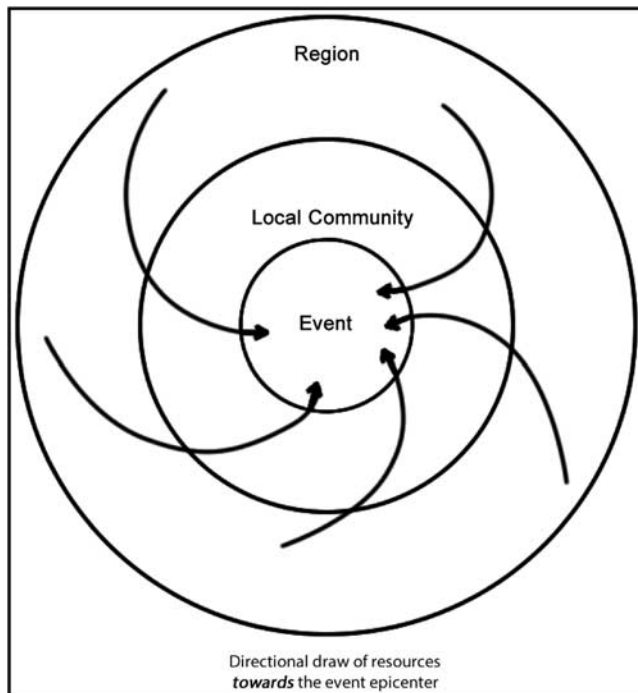
^aNote this event is fictional, but every point is based on real events that have been reported locally or in the literature.

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Figure 1. Example of a Present Day Municipal Event Planning Process

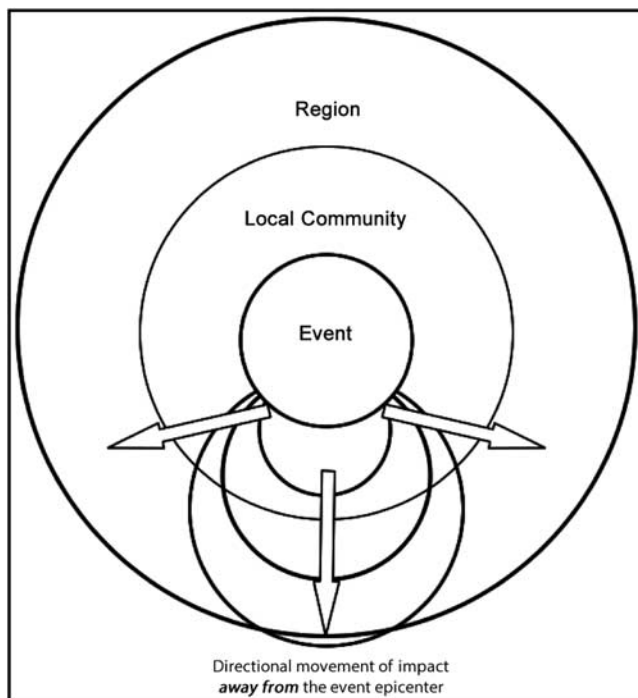
Whistler (British Columbia, Canada), the closest ED had to remain open for extended hours (normally, the ED closed at 10:00 PM). Of note, in the context of most small to medium

sized events, funding is rarely provided by event organizers or government with regard to the additional costs accrued at the level of the ED, hospital, or health authority.



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Figure 2. Vortex Effect (Consumptive)



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Figure 3. Ripple Effect (Disruptive)

Scene Response and ED Wait Times

Prolonged scene response times in the community may impact first response services (eg, firefighters), whose normal role may include stabilizing patients until arrival of paramedic services. First responders may have to manage patients for a longer period of time, or may be called to less urgent calls. In that situation, the

Magnifying Factor	Description
Higher than Predicted Patient Volume at Event	Due to <i>unpredicted</i> factors, such as extreme weather and radical crowd behavior, or rare accidents, such as structural failure leading to mass casualties.
Inadequate Quantity of Onsite Resources	Insufficient personnel and/or equipment resources to respond to <i>predictable</i> patient presentations at an event (ie, the onsite team is overwhelmed by volume).
Inadequate Level of Onsite Resources	Level of care lower than predictable patient acuity (ie, only first aid services are in place when more advanced medical services are predictably required, such as an electronic dance music event).
Inadequate Emergency Transport Planning	Failure to plan for onsite/standby/contracted ambulance services to meet the predictable demands for patient transports.
Inadequate Nonemergency Transport Planning	Failure to consider safe alternative to transport patients to ED, lab, X-ray clinic, or to a central medical facility at the event (ie, vans or shuttles to “sweep” a race or service a finish line).

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Table 1. Factors That Magnify the Vortex Effect

Abbreviation: ED, emergency department.

consequences of the vortex effect include lengthened ambulance response times and depletion of baseline resources for the host community, including increased use of allied services. In this sense, the power of the vortex can be felt at times across multiple agencies or organizations. Police and paramedics may be similarly affected by the vortex effect of special events.

An increased number of visits to the closest EDs may also have an impact on wait times, and time to being seen by a physician or nurse practitioner. Anecdotally, onsite medical services providers, paramedics, and ED personnel relate multiple examples of when they were “slammed” with an unpredicted surge of patients related to a community special event. Planning that does occur frequently occurs in silos, and is not linked to those who will be expected to respond to the increased number of ambulance transfers or ED visits, and to respond in the event of a MCI.

Temporality and the Vortex Effect

The discussion so far has focused to a great extent, on the consumption of services on the day of the event itself. However, the effects before and after the fact should be considered, for example, in the case of the spread of infectious disease⁹⁻¹⁵ only recognized after the events have concluded.

Magnification of the Vortex Effect

Anecdotally, the effects of the vortex may be magnified under certain conditions (Table 1). Mass gatherings and special events exert a vortex effect and can drain local health services into

Effect	Description
Event Boundaries	Fencing, site enclosure, security restrictions, and road closures may cause diversions of vehicle, cycle, and pedestrian traffic.
Access Issues	Closure or reduced access to buildings, services, or locations associated with, or affected by, the event or its site.
Public Space	Loss of use of public locations for event purposes (eg, parks used for camping at multi-day festivals).
Transportation	Restricted parking, increased traffic in surrounding area, and reduced availability of transportation (eg, normal air travel capacity taken up by visitors to event).
Communications	Increased media coverage.
Civil Liberty	Increased security measures in general area.
Services	Stressed community resources, including public safety and health/medical facilities and services.

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Table 2. Geographic (place-based) Examples of the Ripple Effect

providing care before, during, and after an event within both the host and surrounding communities.

The Ripple Effect

The ripple metaphor represents the waves of energy that move away from a central disturbance in a body of water, spreading outward and disrupting the status quo. This is an apt metaphor for MGs as the resulting disruptions in health service infrastructure may be felt at variable distances from the event site (Table 2) and for hours, or days, before, during, and after an event (Table 3).

In terms of community infrastructure, the effects of MGs do not remain contained within the temporary fences that may be erected to define their boundaries. Events with a large geographic footprint, such as a marathon, may disrupt normal community functions for windows of time over many kilometers. These effects are most pronounced in the areas closest to the event, and, in general, are less pronounced as the distance from the event center increases. Time-wise, the effects often peak just before, during, and immediately after an event's opening and closing hours, with the ingress and egress of thousands of people.

Extreme Ripple and Vortex Effects—Mass-casualty Incidents

The above discussion conceptualizes the consumptive and disruptive effects of a given MG in the normal course of event planning and execution. Absent from the discussion above are extreme examples of the vortex and ripple effects, arising in relation to (but not directly caused by) MGs (for example, the Boston Marathon (Massachusetts USA) finish line bombing in 2013).¹⁶

In February 2012, at the Port Said (Egypt) football stampede/riot, a thousand people were reported to be injured and 74 were killed during the riot; however, post-event, during the public

Description	Time of Effect
Allocation of Resources for Planning	Before and During
Administration by All Event Stakeholders	Before, During, and After
Set Up and Tear Down of Infrastructure	Before and After
Use of Community Health Resources for Patients Attending Event	Before, During, and After
Fatigue, Disrupted Schedules, and Other Personnel Effects	During and After
Treatment and Recovery of Hospitalized Patients	During and After
Use of Community Health Resources for Patients Outside of the Event or After the Event	During and After
Damage to Local Infrastructure/Time to Return Event Resources to Operational Status	After

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Table 3. Temporal (time-based) Examples of the Ripple Effect

funeral for the deceased, a further three were killed and 400 injured.¹⁷

In the United Kingdom on November 4, 2011, a spectacular fireworks show held at a private club led to a multi-car pileup on a busy London M-road; planners were held legally responsible for the resulting seven deaths and 51 injured.¹⁸

In October of 2007, 14 women were crushed to death and 40 others were injured when a human stampede occurred at a train station in Mughalsarai (Uttar Pradesh, India). The station was overcrowded due to pilgrims travelling from a religious festival.¹⁹

Although the above examples may be out of scope of an everyday event planning perspective, they are almost certainly relevant from a public policy and emergency management planning perspective, and disaster planning should be considered in the context of risk analysis for every major MG.²⁰⁻²³

Reversing the Vortex and the Ripple Effects

Although this report has focused primarily on the potential negative effects of MGs in terms of their community impact, positive impacts may also be appreciated. On some occasions, the vortex and the ripple may be reversed, leading to positive outcomes for host and surrounding communities. Consider the opportunities with regard to training and experience for personnel, as well as the legacy structures and resources that contribute in positive ways to the overall capacity of the system (eg, British Columbia's Mobile Medical Unit, a legacy from the 2010 Winter Olympic Games).²⁴ Thinking broadly about the health effects of MGs, Tewari and colleagues described the positive health effects for a population attending an annual religious gathering.²⁵ Strategies to "reverse the vortex" will be invaluable for event planners and government officials. As such, strategies should be an important consideration when balanced against the total "costs" of a given event.

Discussion

In relation to understanding the full impact of MGs, the absence of a strong theoretical framework, the current lack of an international agreement on a set of variables that should be considered (ie, a minimum data set),^{26–28} and the absence of an international database for the collection and storage of data about mass-gathering health (MGH)^{6,28–30} means that a sophisticated understanding of the issues is currently beyond reach.

The concepts of the vortex and ripple effects were developed while seeking indicators that might illuminate the impact that MGs have on local prehospital and ED systems. Employing these metaphors encouraged the consideration of operational implications beyond immediate and obvious variables, such as patient transport rates and patient visits to local EDs.

Arguably, the MG literature currently explores a wide range of health and community resource effects for large scale events, such as the Olympic Games, with a focus on everything from transportation infrastructure³¹ and public health^{32,33} to long-term population health effects.³⁴ Much less well-understood are the effects of small, medium, and large-scale events, such as marathons, concerts, and the countless events that occur regularly in local communities around the world. In this context, the vortex and ripple effects are more than simply interesting metaphors. Together, these concepts help foster insight and allow better exploration of the impact of MGs on local communities.

Understanding the vortex and ripple effects may provide a mechanism for identifying stakeholders who should be involved in the planning process. These community stakeholders have a vested interest in ensuring adequate planning to prevent, or minimize, the vortex effect in their community by having event producers take reasonable responsibility for the safety and emergency response planning for the event. For example, one of the ways to minimize the burden on local health care services is to offer risk-relevant onsite first aid and/or advanced health services throughout a special event.^{6,21,35–38} The MG literature is replete with case reports detailing event medical services. Because MGs consume local health care resources and disrupt baseline functioning in the local and surrounding communities, these stakeholders must also be part of the planning process.

In British Columbia, event permits are typically granted at the municipal level to event producers. The process is not consistent from city to city, and not every jurisdiction requires comprehensive input from all stakeholders. There is inconsistent “veto power” when it comes to event safety issues (Personal Communication, Ron Ford, Special Operations Coordinator, November 12, 2013), which results in permits being granted without input from all health stakeholders. Although an event permit may be withheld for failure to meet fire regulations, or because of security concerns by policing authorities, there is no similar veto power by local EMS;

as well, local EDs, hospitals, and health authorities have little to no influence in the permit granting process. This is, no doubt, partly due to the fact that evidence regarding the overall impact of special events on local health service levels is thin (eg, EDs and ambulance services). Finally, in the British Columbia context, permits are granted municipally, but health services are administered provincially, and therefore may be “assumed” in the permitting process.

Finally, both metaphors may be useful in additional, as yet, unexplored ways. For example, if considered more broadly, the vortex effect may be a way to understand not only the pull on health care resources, but also on other community infrastructure, such as policing, firefighting, maintenance services, transportation,³¹ as well as the long-term effects,³⁴ and so on. More broadly, a cohesive conceptual framework could support researchers and clinicians in exploring risk assessment and management as the MGH community works toward integrating the disparate professionals focusing on risk mitigation.^{20,39,40}

Limitations and Future Directions

While the focus of this report was on generating discussion around the concepts of the “vortex effect” and the “ripple effect,” these are currently limited to qualitative description. A comprehensive study of community impact has not been reported in the MGH literature. Before this can happen, work underway must be completed to determine appropriate data points that will serve as clinically and practically important impact measures on both the prehospital (ambulance) services, and the acute health services (ie, EDs), as well as other community resources. A quantitative analysis using standardized data points for community impact reporting may be an outcome of collaborative work to develop a research framework for MG.

Understanding the full impact—both the vortex (eg, draw on local health resources) and ripple effects (eg, disruption of baseline community function—of a given event may be useful in the context of policy and legislation with regard to MGs. In addition, municipalities and city council members may find it helpful to consider the broader implications of special events to more accurately plan for health service requirements.

Conclusion

Special events and MGs impact host communities by drawing resources towards them (vortex), and by disrupting normal, baseline services (ripple) over geography and time. Well-developed medical and safety plans for events, with appropriate, comprehensive risk assessments and stakeholder engagement, have the best chance of ameliorating the potential negative impact of MGs on a community.

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