

Mass-Gathering Medicine: Creation of an Online Event and Patient Registry

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Conflicts of interest: All authors participate as providers at mass-gathering medicine events, and occasionally receive an honorarium or pay for clinical work at funded events. All authors also volunteer their time providing clinical care at nonprofit events. Co-author Michael Carson is the owner of Trivent Consulting, a software design company focusing on event management for triathlons.

Keywords: concerts; database; emergency medicine; festival; mass gathering; mass participation; prehospital; registry; sporting event

Abbreviations:

ATR: ambulance transfer rate
MGM: mass-gathering medicine
MTR: medical transfer rate
PEF: patient encounter form
PPR: patient presentation rate

Received: July 27, 2011

Accepted: September 14, 2011

Revised: August 17, 2012

Online publication: October 3, 2012

doi:10.1017/S1049023X12001367

Abstract

Introduction/Problem: A review of the mass-gathering medicine literature confirms that the research community currently lacks a standardized approach to data collection and reporting in relation to large-scale community events. This lack of consistency, particularly with regard to event characteristics, patient characteristics, acuity determination, and reporting of illness and injury rates makes comparisons between and across events difficult. In addition, a lack of access to good data across events makes planning medical support on-site, for transport, and at receiving hospitals, challenging. This report describes the development of an Internet-hosted, secure registry for event and patient data in relation to mass gatherings.

Methods: Descriptive; development and pilot testing of a Web-based event and patient registry.

Results: Several iterations of the registry have resulted in a cross-event platform for standardized data collection at a variety of events. Registry and reporting field descriptions, successes, and challenges are discussed based on pilot testing and early implementation over two years of event enrollment.

Conclusion: The Mass-Gathering Medicine Event and Patient Registry provides an effective tool for recording and reporting both event and patient-related variables in the context of mass-gathering events. Standardizing data collection will serve researchers and policy makers well. The structure of the database permits numerous queries to be written to generate standardized reports of similar and dissimilar events, which supports hypothesis generation and the development of theoretical foundations in mass-gathering medicine.

Lund A, Turriss SA, Amiri N, Lewis K, Carson M. Mass-gathering medicine: creation of an online event and patient registry. *Prehosp Disaster Med.* 2012;27(6):601-611.

Introduction

In recent decades the need for more consistent emergency medical services at mass gatherings has been identified. The presence of a medical team—able to provide rapid assessment of patients, including triage, treatment, stabilization and transportation of those seriously injured to off-site medical facilities—is increasingly discussed in the literature.¹⁻³ The Mass Gathering Medicine (MGM) Interest Group (<http://www.ubcmgm.ca>) in the Department of Emergency Medicine at the University of British Columbia, Canada, consists of interested clinicians who have provided care at community events for more than two decades. In 2008, an academic team committed to studying MGM in a rigorous manner was assembled.

Despite the fact that mass gatherings are frequent occurrences with some common nomenclature (Table 1), record keeping and data collection with regard to the presenting injuries and illnesses that occur during such events remain challenging. A variety of patient encounter forms (PEF) are in use, and currently there is no standardization with regard to a minimum data set, although such efforts are underway in the international context. Furthermore, no systematic approach to data collection and analysis for determining the relative influence of event and patient-related factors on illness and injury rates exists in the published literature. Standardized data collection tools for use during mass gatherings, encompassing both an event and patient focus, would be invaluable for researchers as this would allow for comparison between events and over time, building both the theory and evidence base for mass-gathering medicine.

The present report describes the development and pilot implementation of a Web-based event and patient registry for the purpose of capturing event and patient

Abbreviation ^a	Meaning
PPR: Patient presentation rate	Number of patients seen on-site
ATR: Ambulance transfer rate	Number patients transferred by ambulance
MTR: Medical transfer rate ^b	Sum of ATR plus transfer by any other means (ie, van, taxi, private vehicle, etc.) to hospital, clinic, laboratory, X-ray facility, etc.

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Table 1. Commonly Used Abbreviations^aAll rates are per 1,000 attendees/staff/volunteers at event.^bMTR is preferred by the team over TTHR (transfer to hospital rate), also used in the MGM literature, since not all transfers are to a hospital.

encounter data for a cross-section of mass-gathering events during a three-year period in British Columbia, Canada. The Registry will provide a comprehensive sample database of events and patient encounters, allowing for descriptive observations regarding patient presentations at different types of events over several seasons. Study funding permits the enrollment of a limited number of events on an annual basis for three years. Ethics approval was obtained from the University of British Columbia's Behavioural Research Ethics Board.

Background and Literature Synthesis

In reviewing the available mass-gathering medicine literature, the team focused on three main areas: (1) Current methods of data collection with regard to mass gatherings; (2) How results generally are reported; and (3) What a systematic approach to data collection during mass gatherings (ie, an event and patient registry) might provide for researchers, event planners, members of the medical team, and local governments or permit-granting agencies?

Mass-Gathering Medicine, Data Collection, Data Analysis, and Reporting

In relation to data collection and *patient characteristics*, many data fields were in common use (eg, name, date, time, chief complaint, treatment provided). Unique fields specific to certain types of events (eg, bib number, category of event participant) also were identified. Of note, fields postulated to be important were found to be "missing" both within the literature and on many of the

reviewed PEFs. For example, in contrast with other fields of medicine, there are few reports with regard to patient encounters for health-promoting services or illness prevention despite the fact that individuals may present in significant numbers for such services. Gutman, Lund, and Turris² reported that 27.7% of individuals presenting to the medical team during the 2009 World Police and Fire Games received services focused on prevention, including massage therapy, taping, and other prevention-focused interventions. Overall, there was a wide heterogeneity in ways that researchers, medical professionals, and event organizers have captured data. The majority of event reports reviewed had no centralized record-keeping plan.

The reporting of patient encounter types and acuity was similarly heterogeneous (Table 2). In order to capture the range of patient presentations at events, a variety of strategies was used, including grouping similar presenting complaints and reporting percentages (eg, "lacerations/abrasions" or "musculoskeletal injuries"), reporting according to body system affected (eg, "dermatology" or "cardiac"), and/or according to final diagnosis (eg, "diabetes" or "asthma"). Most common by far was to employ a mix of these three approaches, making comparisons between and among populations and events quite challenging. In addition, measures of acuity and acuity determination varied widely. For example, some teams used "minor" and "major" designations⁴ and others used additional categories.⁵ Given the well-recognized need for rigorous approaches to medical support planning, it was anticipated that this will be an area of interest for MGM researchers in the coming decade.

Year	Primary Author	Title	Event Type	Population	Reporting Format	Comments
1989	Challis ⁶	Medical Services Program for the 1988 Winter Olympic Games	Sport	Adult	Mixed (systems and presenting concern)	"fracture" and "MSK"
1991	Hnатов ³	Medical Planning for Mass Gatherings: A Retrospective Review of the San Antonio Papal Mass	Religious	Adult	Presenting concern	12 categories
1992	Rose ⁷	Emergency Medical Services for Collegiate Football Games: A Six and One-half Year Review	Sport	Adult	Systems	24 categories
1992	Fulde ⁸	Open Air Rock Concert	Musical (rock concert)	Adult	Mixed (diagnosis and presenting concern)	"asthma" and "hyperventilation"

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Table 2. Examples of Categories Used to Classify Patient Encounters (*continued*)

Year	Primary Author	Title	Event Type	Population	Reporting Format	Comments
1993	McDonald ⁹	Medical Control of Mass Gatherings: Can Paramedics Perform Without Physicians On-site	Multiple	Adult	Presenting concern	33 categories. Named as "provisional diagnosis" but primarily presenting concern.
1996	Perdomo ¹⁰	Public Health Surveillance During the XVII Central American and Caribbean Games – Puerto Rico, November 1993	Sport	Adult	Systems	"orthopedic" and "respiratory"
1996	Hewitt ¹¹	Emergency Medicine at a Large Rock Festival	Musical (rock concert)	Adult	Mixed (systems and presenting concern)	"orthopedic" and "headache"
2002	Zeitz ¹²	Mass Gathering Events: Retrospective Analysis of Patient Presentations Over Seven Years at an Agricultural and Horticultural Show	Other	Not reported	Other	"major disease" and "minor disease"
2003	Milsten ¹³	Variables Influencing Medical Usage Rates, Injury Patterns, and Levels of Care for Mass Gatherings	Multiple	Not reported	Mixed (diagnosis, presenting concern, systems)	
2003	Thierbach ¹⁴	Medical Support for Children's Mass Gatherings	Fair	Pediatric	Other	"major disease" and "pain" and "psychiatric"
2004	Sloan ¹⁵	Injury Incidence During the 2001 World Police and Fire Games	Sport	Adult	Mixed (presenting concern, diagnosis)	"headache" and "asthma"
2004	Morimura ¹⁶	Analysis of Patient Load Data from the 2002 FIFA World Cup Korea/Japan	Sport	Adult	Mixed (systems and presenting complaint)	18 categories
2004	Feldman ¹⁷	Half-a-Million Strong: The Emergency Medical Services Response to a Single-Day, Mass-Gathering Event	Musical (rock concert)	Adult	Presenting concern	9 categories
2005	Olapade-Olaopa ⁴	On-site Physicians at a Major Sporting Event in Nigeria	Sport	Adult	Other	"minor, "intermediate" and "major"
2006	Johnsson ¹⁸	Medical Support During the European Union Summit in Gothenburg, Sweden, June 2001	Other	Adult	Presenting concern	
2007	Yazawa ¹⁹	Medical Care for a Mass Gathering: The Suwa Onbashira Festival	Festival	Not reported	Other	"Trauma" (basic advanced or life threatening) or "medical problems" (basic or advanced)
2010	Grant ²⁰	Mass-Gathering Medical Care: Retrospective Analysis of Patient Presentations Over Five Years at a Multi-Day Mass Gathering	Fair	Not reported	Mixed (systems, diagnoses, presenting concern)	"burn" and "diabetes" and OB/Gyne"
2011	Gutman ²	Medical Support for the 2009 World Police and Fire Games: A Descriptive Analysis of a Large-Scale Participation Event and Its Impact	Sport	Adult	Systems	7 categories

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Table 2. (continued) Examples of Categories Used to Classify Patient Encounters

In terms of understanding *event characteristics*, there are two landmark papers in the MGM literature. Milsten et al²¹ synthesized the existing mass-gathering literature and summarized the many variables including weather (temperature and humidity), event duration, location (indoor vs. outdoor), geography, event boundaries (fenced, contained vs. unbound), event type, alcohol and drug availability, crowd seating (mobile vs. seated), density, mood, and average age that influence patient presentation rate (PPR). Arbon²² presented conceptual work with regard to the psychosocial, environmental, and biomedical domains of mass gatherings and their influence on PPR. As well, there has been ongoing work both retrospectively²³⁻²⁶ and prospectively²⁷ to verify the utility of specific variables in predicting the PPR. For example, Shah²⁷ accurately predicted presentation rates drawing on 11 years of data from the Galway Races, based solely on the previous PPRs.

Arguably the main purpose of collecting event and patient data is to be able to plan medical responses in advance of a future event. Lack of consistent data collection and analysis of the injuries and illnesses that occur during particular types of events makes such planning difficult.^{24,26} Arbon²⁸ noted the lack of a consistent approach to the collection of data to be one of the “impediments” to the development of the theory in mass-gathering research. Several researchers have worked in the area of modelling for the prediction of PPR. Arbon and colleagues provided a model for risk assessment based on a number of predictors (eg, weather, crowd mobility, event boundaries) for events with no previous medical support.²⁹ Although this approach has shown some promise, it lacks utility for inter-day variability. Zeitz and colleagues published a model based on a retrospective review of events. This model has been shown to be helpful for events for which there is prior medical experience in terms of patient presentation.³⁰ However, both models have their limitations, and neither provides data regarding staffing requirements.

There has been early work on how the composition of the medical team impacts medical transfer rate (MTR) and ambulance transfer rate (ATR).^{31,32} More recently, Hartman and colleagues devised a scoring system for predicting resource use based on predictive factors as identified by Milsten.²⁶ Their results showed a good prediction of medical resource needs for “minor” and “intermediate” patient presentations. However, it seems their model has not yet been validated prospectively.

Methods

The study team reviewed the literature to identify event and population factors that have been shown to affect PPR, MTR and ATR as described above. Furthermore, an attempt was made to assemble an inclusive list of event factors that reasonably could have an influence on PPR, either in reducing it (protective/preventative factors), or increasing it (risk factors). Consultation with local, experienced providers and medical response organizers also was utilized to identify factors that were believed to influence the PPR at various types of events, as well as descriptions of the teams and their capabilities that were believed to influence the MTR. Finally, the research team sought out the reporting fields that event organizers would be interested in generating from the Registry and built automated reporting capacity into the Registry design. These data sources and field characteristics were collated into blueprint documents for event, patient, and report data/calculation fields and submitted to the database designer.

1. The “LAMP” development environment was employed: Linux (Version CentOS, CentOS Incorporated, Raleigh, North Carolina, USA, date unknown) for the operating system; Apache as the web server (Version 2.2.17, Apache Foundation, Los Angeles, California, USA, October 18, 2012); MySQL for the database (Version 5.0.95, Oracle Corporation, Redwood Shores, California, USA, 2012); and PHP for the development language (Version 5.2.9, Open Source, 2012).
2. The site is hosted by a third party hosting company (Canadian Webhosting) and Aptana Web (Version 2.0.5.1278522500, Appcelerator Corporation, Mountain View, California, USA, 2010) was used to build the website.
3. The framework of the Registry within the MGM Website included a standard page design (ie, menu design, error checking, and page style), site navigation, site security including login and authentication, design, and creation of the CRUD (create, retrieve, update, and delete) functionality for the data.
4. Post-event reporting was built using Pentaho Business Intelligence Toolkit for MySQL, a database administration tool that allows for the organization and sharing of data (Version 4.5.1, Jaspersoft, San Francisco, California, USA, 2011).

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Table 3. Mass Gathering Medicine Online Registry Project Development Package: Software and “Back-End” Description (in use August 17, 2012)

Architecture of the Registry

The Mass Gathering Medicine Registry was designed to collect and report on medical incidents at mass-gathering events. The Registry home page (<http://www.ubcmgm.ca/registry>) is accessible to the public. Research team members access the Registry through their unique, encrypted login ID and passwords.

The developer created the most recent version of the Registry based on an outline of the data elements provided by the team in April 2010. The design of the Registry (Table 3) was based on a number of factors:

- The need for a flexible solution that could grow with the project;
- Preference for well-supported, open-source software to minimize reliance on a single developer or company for future maintenance or expansion;
- A solution that was cost-effective yet robust;
- An easy-to-use interface that was adaptable to various types of users; and
- A system that was maintainable by a non-technical audience.

Security of Registry Data

The data set is built with three tiers of dependent data, allowing for flexibility in data clustering. The top level of the data is “Event Name” with associated descriptor fields. Below that, “Event Dates” can be added to the “Event Name” in a dependent fashion. Patient encounters then are added to the database under the specific “Event Date.”

In planning the Registry, security was a major consideration due to the sensitive nature of the data being collected (Table 4). In order to control access to the registry, users were categorized into one of four categories (administrators, primary investigation team, co-investigators, data entry) for access and authentication purposes.

Results

The data fields for the MGM Registry were derived through an iterative process of team writing through three draft documents

1. All traffic is encrypted with secure sockets layer (SSL) cryptography.
2. Access to the system is by individually assigned user IDs and passwords.
3. Passwords are a minimum of eight characters with the user being prompted as to the strength of their password.
4. Passwords are known only to the owner and are encrypted using SHA-1 and a 64-bit salt.
5. Access to each page on the site is controlled by user role (data entry role vs. co-investigator vs. primary investigator vs. administrator).
6. Patient records are de-identified upon completion of the event and confirmation of data accuracy, thus ensuring patient anonymity.

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Table 4. Security Features

(*Event Fields, Patient Fields, Reporting Fields*), until a common set of data fields and field properties were agreed upon. Thereafter, the forms were circulated to event producers and medical service providers familiar with the MGM environment for feedback and modification. International input was sought from other research teams studying mass-gathering medicine (Dr. Paul Arbon, personal communication, November 11, 2009) regarding the preliminary work, confirming that similar patient fields had been incorporated into the “minimum data set” that another team also had hypothesized to be relevant. In formulating the MGM Registry, the approach of creating a “maximum reasonable data set” was pursued in order to capture as much information as possible to allow hypothesis generation. Therefore, the “minimum data set” is defined by the mandatory fields (Appendices 1, 2, and 3).

Drawing on common variables cited in the mass-gathering literature, the MGM Registry’s patient fields were constructed with mandatory fields and optional fields (where variability was anticipated). From this work, a generic, customizable, single-page Patient Encounter Form (PEF) was derived. A multi-patient minor treatment log was created, based on the identified need to improve charting compliance for the more numerous, minor patient presentations to MGM teams. Sample forms are viewable at <http://www.ubcmgm.ca/registry>.

The research team primarily captures event and patient data prospectively and, when practical, enters these data on the day of the event. The data fields for characteristics of each event are in Appendices 1 and 2; data fields for patient encounters are in Appendix 3. For economy of data entry, when a brief encounter is recorded, it can be entered into the Registry through an abbreviated interface that does not include the fields for more detailed encounters (ie. vital signs, detailed past medical history). There also is a “clone” feature for the most minor presentations (eg. acetaminophen request, band-aid, simple hydration) or other requests referred to as “dispensary,” the most minor of minor interactions with the medical team, but the most numerous.

Finally, in order to “give something back” to event planners and medical directors who consent to have data from their events entered into the Registry, there are value added reporting features. For each event, a report is generated and provided for the event planner (Appendix 1). A second report, generated for the medical director, outputs all of the patient records (prior to de-identification) in an electronic, portable document format (PDF) for legible record keeping. The event and patient data that have been entered into the MGM Registry as of July 19, 2011 are summarized in Table 5.

Discussion

Despite numerous descriptive reports of patient numbers, case mixes, presentation rates, and specific encounters in the literature, currently no uniform guidelines for data collection at mass-gathering and mass-participation events exist in the Canadian context. The MGM Registry is one possible method of supporting data collection and data analysis with regard to mass gatherings that, in the future, might provide information and knowledge to underpin MGM policy development.

The research team for this project was able to locate a single report in the literature with regard to the use of an electronic registry for mass gatherings. Zeitz and colleagues reported on a pilot study in which an electronic patient surveillance system was used by South Australia St John Ambulance.³³ A limitation of their study was the strict exclusion of data from all medical presentations, as well as blister and uncomplicated splinter injuries. Patient encounters that occurred as a result of traumatic injury were the exclusive focus of data collection, and they had the ability to map the location of injuries when they occurred. Zeitz and colleagues were interested in mapping potential hazards at specific events in real time so that further injuries could be prevented. Accordingly, their team had the capacity for real-time surveillance and communication with other agencies and groups on-site to have hazards addressed in a timely fashion. Currently, the MGM Event and Patient Registry does not capture information regarding geographical location of the injury on-site. Nevertheless, injury trends have been identified. For instance, a higher than expected rate of “kitchen” injuries at musical events with volunteer staff was observed, permitting in-time training to be implemented. Future ability for live reporting and communication with other agencies can empower the research team to transfer this knowledge to appropriate authorities in a more timely fashion, based on Zeitz’s and our own work.

Two related research questions arose during the development of the “Patient Encounters” section of the Registry related to: (1) acuity determination, and (2) categorizing illness and injury. At this time, no validated triage or acuity scoring system for use in the somewhat unique setting of mass gatherings exists.⁵ In categorizing the *type* of the patient encounter, there is a high degree of heterogeneity. Nguyen et al assigned level of care based on time spent with patients (<5 minutes minor care, basic 5-15 minutes, advanced >15 minutes).³⁴ They grouped patients requesting medication or a bandage as a “minor category.” Johnson and colleagues devised a three-tier category system based on the urgency of the medical needs of the presenting patients where Category I represented immediate need, and Category III could await a “delayed” response.¹⁸ In creating the Registry, there needed to be a way to “measure” acuity for a wide variety of purposes including (but not limited to) equipment and human resource planning. Drawing on the traditions of START³⁵ and CTAS,^{36,37} a five-category triage system was created and is described elsewhere.⁵ One of the unique contributions of this approach is the ability to capture patient encounters in which acuity is a non-issue (eg, the treatment of a blister, sunscreen request, water request) under the category “dispensary.” Testing of this triage system currently is underway (see <http://www.ubcmgm.ca - Research section>).

Arbon noted that the use of common categories for patient presentation (illness and injury groups) would facilitate sharing of data and comparison across events.²² For the MGM Registry, the developers adopted a three-pronged approach to injury and illness

Event Name	Year	Event Days	Patient Encounters	Total Estimated Attendance	PPR
Abbotsford International Airshow	2010	3	149	94,000	1.59
Armin Van Buuren (disc jockey show)	2010	1	5	3,783	1.32
BC Bike Race (mountain bike race)	2010	7	526	3,500	1,052.00
David Guetta (disc jockey show)	2010	1	14	6,540	2.14
Black Keys (outdoor concert)	2011	1	39	8,000	4.88
Kid Cudi (outdoor concert)	2011	1	8	8,000	1.00
Tragically Hip (outdoor concert)	2011	1	15	9,000	1.67
Lilith Fair (outdoor music festival)	2010	1	47	7,787	6.04
Live at Squamish (outdoor music festival)	2010	2	80	13,371	5.98
LiveCity Downtown (Olympic celebration site)	2010	16	405	162,628	2.49
LiveCity Paralympics	2010	7	38	100,000	0.38
Livecity Yaletown	2010	18	624	418,516	1.49
Ride to Conquer Cancer (charitable bike race)	2010	2	1987	4,506	440.97
Ride to Conquer Cancer	2011	2	1857	5,758	322.51
Scotia Half Marathon & 5 K ^a	2009	1	31	5,000	6.20
Scotia Half Marathon & 5 K	2010	1	121	5,350	22.62
Scotia Half Marathon & 5 K	2011	1	133	6,200	21.45
Seasonfest (DJ show)	2011	1	11	3,000	3.67
Sun Run (10 km fun run)	2009	1	54	50,000	1.08
Sun Run	2010	1	175	51,419	3.40
Sun Run	2011	1	159	49,365	3.22
Surrey 2012 Celebration (Olympic celebration site)	2010	17	136	150,000	0.91
Underwear Affair (5 km charitable run)	2010	1	4	2,500	1.60
Vancouver Folk Music Festival	2010	3	411	30,000	13.70
Vancouver Folk Music Festival	2011	3	226	24,000	9.42
Vancouver International Marathon ^a	2006	1	572	14,395	39.74
Vancouver International Marathon ^a	2007	1	537	12,600	42.62
Vancouver International Marathon ^a	2008	1	499	12,000	41.58
Vancouver International Marathon ^a	2009	1	531	13,000	40.85
Vancouver International Marathon ^a	2010	1	412	14,175	29.07
Vancouver International Marathon ^a	2011	1	435	14,028	31.01
Vancouver Island Music Festival	2011	4	313	18,000	17.39
Weekend to End Women's Cancers (60 km charitable walk)	2010	2	628	3,000	209.33
Totals		106	11,182	1,323,421	8.45 (mean)

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Table 5. Events Enrolled in the University of British Columbia, Department of Emergency Medicine, Mass Gathering Medicine Registry, through July 19, 2011

Abbreviation: PPR, patient presentation rate.

^aLack of standardized charting for data prior to 2010 makes PPR less accurate (underestimates).

categorization so that Registry data might be compatible with that of other researchers, regardless of the reporting categories used:

- (1) Incorporation of ICD-10 codes, which allow the data entry team to categorize illnesses and injuries according to systems (eg, diseases of the respiratory system);
- (2) The Registry captures information about presenting complaint (eg, "shortness of breath"); and
- (3) The discharge diagnosis when provided by the care provider (eg, asthma exacerbation).

Limitations

The nature of MGM events present some challenges when it comes to coordinated data entry, as data entry is not always possible on site. The specific event profile has been a factor. At events such as music festivals, the number of patients presenting each hour is more or less flat, permitting research team members to "keep up" with data entry. In contrast, at sporting events such as the Vancouver Sun Run, a 10 km run with >55,000 attendees, or the Vancouver International Marathon, simultaneous data entry was not possible due to the massive peak of patient presentations over a short period of time. Mobile events such as the Ride to Conquer Cancer, a two-day cycling charity ride involving dispersed providers, a moving medical response team, and roaming Internet access issues, made data entry in real time too difficult to accomplish with existing resources. Similarly, real-time data entry is challenging when multiple sites of care are utilized at an event.

Completeness of documentation remains a challenge, and when data entry is not accomplished on-site, there is no opportunity for the research team to approach providers to "back fill" the data. At times the legibility of the completed PEFs also has been difficult to interpret. This is a problem common to health care charting in many environments.

The full burden of illness and injury at MGM events is underestimated. At present there is no access to patient data for those who leave the event for care at community clinics or emergency departments without presenting to the on-site medical team.

Presently, funding is available for entering the data at accessible events for one final year of the three-year study period. Outstanding issues including data entry costs, expenses related to maintenance and portable Internet access, funding for ongoing research projects, and expansion of the use of the Registry provincially, nationally, and internationally will dictate its continued utilization.

Future Directions

Consistency of data collection will allow researchers and medical providers in diverse jurisdictions to systematically describe both the population of *Events* as well as the population of *Patients*. Ultimately, this will allow for observations and comparisons within

and between unique events and ultimately, the pooled population of patients in similar events provincially, nationally, and perhaps in the future, internationally. Researchers would be in a position to analyze risk factors, safety features, as well as the size and nature of medical teams and their influence on the ATR and MTR. Currently, there is a dearth of models in the literature that predict PPR prospectively. There is an identified need for uniform guidelines for the provision of health services at mass gatherings that has not yet been addressed due to lack of consistent research frameworks and an absence of theory development.^{1,22,28} This lack of evidence, to some extent, has hindered the development of policy with regard to mass gatherings and medical support, at least in the Canadian context.

Ultimately, the adoption of a centralized Registry could allow MGM research teams to more accurately:

- (1) Describe the patient populations at various unique MGM events;
- (2) Document PPR and case mixes at similar and different MGM events;
- (3) Hypothesize regarding event variables that affect the PPR, ATR, and MTR;
- (4) Analyze the effects of the size and composition of the medical team on the ATR and MTR;
- (5) Describe the equipment, medications, and protocol variability and hypothesize regarding their influence on transfer rates; and
- (6) Document the frequency of rare events (eg, cardiac arrest, major trauma, mass-casualty incidents) through the collation of data from many events over multiple years and participating jurisdictions.

In the future, the incorporation of local emergency department visit data is planned. In addition, the design of the Registry could permit real-time data entry by care providers using portable devices such as iPads.

Conclusions

The Mass Gathering Medicine Event and Patient Registry provides an effective tool for recording both event and patient-related variables and automating relevant reports for event organizers in the context of mass-gathering and mass-participation events. Standardizing data collection will serve researchers and policy makers well. The systematic collection of data supports hypothesis generation and the advancement of theoretical foundations in MGM.

Acknowledgments

The authors acknowledge the work of Trivent Consulting in database design, Dr. Samuel Gutman and RockDoc Consulting, the British Columbia Ambulance Service Special Operations Division, SportMedBC, St John Ambulance Service, and the Vancouver Folk Music Festival Society.

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Appendix 1. Data Fields in “Event Description” in the University of British Columbia, Department of Emergency Medicine, Mass Gathering Medicine Registry (continued)

Data Field	Retrospective Collection	Organizer Report	Mandatory Fields
Demographics of Event			
• Event name		✓	✓
• Date		✓	✓
• Location		✓	✓
• Season		✓	✓
• Is data entry retrospective or prospective?			✓
Descriptors of Event			
• Total event hours for day			✓
• Event hours			✓
• Accommodation type			✓
• Arrival prior to gate opening			
• Category of event (mainly participants, spectators, etc.)			✓
• Best event descriptor (athletic, concert, community, orator)			✓
• If concert, active stage front?			✓
• Adult cost for general admission			✓
• Discounted admission day			✓
• Seating arrangement			✓
• Event boundaries		✓	✓
• Community context (rural, urban, suburban)		✓	✓
• Location (outdoor vs. indoor)		✓	✓
If outdoor – exposure (mainly covered vs. uncovered)			
• Terrain type (even vs. uneven)			

Appendix 1. (continued) Data Fields in “Event Description” in the University of British Columbia, Department of Emergency Medicine, Mass Gathering Medicine Registry

Data Field	Retrospective Collection	Organizer Report	Mandatory Fields
Descriptors of Crowd <ul style="list-style-type: none"> ● Total attendance of the day ● Percentage of crowd breakdown (child, adolescents, adult, elder) ● Determination of crowd breakdown (ticket sales, best estimate, unknown) ● Crowd density ● Crowd mood 	✓ ✓ ✓ ✓ ✓	✓	✓ ✓ ✓ ✓ ✓
Risk Factors – multi-check fields <ul style="list-style-type: none"> ● Unique risks identified at the event (e.g. fireworks, lakes, unlit pathways/areas) ● Drugs and alcohol use/sale at the event 	✓ ✓	✓ ✓	✓ ✓
Protective Factors – multi-check fields <ul style="list-style-type: none"> ● Security arrangements in place (contracted vs. in-house, door searches for contraband, visible police presence) ● Guest comforts at the event (eg, concessions stands, ear protection, misting station) ● Weather conditions (minimum, maximum, mean, humidity, sky conditions) 	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓
Describe any reported deaths that occurred ~3 hours before, or ~6 hours after the event	✓		✓
Medical team composition – multi-check fields <ul style="list-style-type: none"> ● Who was the medical care provider? ● Quantity of medical staff present at the event ● Type of remuneration provided to medical team ● Communication set-up ● Number of medical teams/locations/assets on site 	✓ ✓ ✓ ✓ ✓	✓ ✓	✓ ✓ ✓ ✓

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Appendix 2. Medical Care Capability Question in the University of British Columbia, Department of Emergency Medicine, Mass Gathering Medicine Registry

<p>BLS Questions</p> <ol style="list-style-type: none"> 1. Can your team provide basic life support (BLS) care, including CPR and non-invasive airway manoeuvres? 2. Are you equipped to deliver oxygen to patients on site? 3. Are you equipped with at least one automated external defibrillator (AED) or manual defibrillator on site? 4. Are you able to provide intravenous crystalloid to patients at your event? 5. Do you have the capacity to measure blood sugar AND to treat patients with hypoglycemia? 6. Are you able to measure oxygen saturation as one of the vital signs?
<p>ALS Questions</p> <ol style="list-style-type: none"> 7. Is your team equipped and able to provide advanced life support (ALS) care on site until paramedics arrive? 8. Is your team equipped and able to provide advanced airway management, such as LMA, King LT, Combitube, or endotracheal intubation? 9. Does your team have medications necessary to manage a cardiac arrest on site at the advanced life support level? 10. Does your team have access to a full monitor/defibrillator with pacing capabilities?
<p>Medical Questions</p> <ol style="list-style-type: none"> 11. Do you supply oral, over the counter medications for your team to dispense to patients? (e.g., acetaminophen, ibuprofen, etc)? 12. Do you supply any prescription medications for appropriate members of your team to dispense? (i.e., antibiotics, pain medications, etc)? 13. Do you supply any parenteral/IV medications for your team to use during emergencies at your event? 14. Do you supply any narcotics or other controlled substances for use on patients by appropriate members of your team?
<p>Trauma Questions</p> <ol style="list-style-type: none"> 15. Are you equipped to deal with minor wounds, blisters, minor burns, etc? 16. Is your team equipped and capable of doing complex wound management, such as suturing, gluing, etc? 17. Is your team able to immobilize extremity fractures? 18. Is your team equipped and trained to provide spinal immobilization to suspected trauma patients on site, such that they could be packaged and moved if necessary?
<p>Environmental Emergency Questions</p> <ol style="list-style-type: none"> 19. Are you equipped to manage emergencies related to cold, wet weather (i.e., hypothermia)? 20. Are you equipped to manage emergencies related to excessive heat exposure? 21. Does your team dispense preventative health items such as any one of the following: sunscreen, bug spray, ear plugs, condoms, hygiene products, etc?
<p>Infrastructure Questions</p> <ol style="list-style-type: none"> 22. At your main care site, are you able to manage patients who require "lie down" care on beds or cots? 23. Are you able to transport patients on your site who cannot walk either by wheelchair, stretcher, or ride on cart (i.e., golf cart or Gator)? 24. Does your team have a communication device, such as a radio or phone for every provider or team on site?

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Abbreviations: ALS, advanced life support; BLS, basic life support; IV, intravenous; King LT, reusable supraglottic airway (King Systems: Noblesville, Indiana USA); LMA, laryngeal mask airway.

