ORIGINAL RESEARCH

Planning Volunteer Responses to Low-Volume Mass Gatherings: Do Event Characteristics Predict Patient Workload?

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Abstract

Introduction: Workforce planning for first aid and medical coverage of mass gatherings is hampered by limited research. In particular, the characteristics and likely presentation patterns of low-volume mass gatherings of between several hundred to several thousand people are poorly described in the existing literature.

Objectives: This study was conducted to:

1. Describe key patient and event characteristics of medical presentations at a series of mass gatherings, including events smaller than those previously described in the literature;
2. Determine whether event type and event size affect the mean number of patients presenting for treatment per event, and specifically, whether the 1:2,000 deployment rule used by St John Ambulance Australia is appropriate; and
3. Identify factors that are predictive of injury at mass gatherings.

Methods: A retrospective, observational, case-series design was used to examine all cases treated by two Divisions of St John Ambulance (Queensland) in the greater metropolitan Brisbane region over a three-year period (01 January 2002–31 December 2004). Data were obtained from routinely collected patient treatment forms completed by St John officers at the time of treatment. Event-related data (e.g., weather, event size) were obtained from event forms designed for this study. Outcome measures include: total and average number of patient presentations for each event; event type; and event size category. Descriptive analyses were conducted using chi-square tests, and mean presentations per event and event type were investigated using Kruskal-Wallis tests. Logistic regression analyses were used to identify variables independently associated with injury presentation (compared with non-injury presentations).

Results: Over the three-year study period, St John Ambulance officers treated 705 patients over 156 separate events. The mean number of patients who presented with any medical condition at small events (≤2,000 attendees) did not differ significantly from that of large (>2,000 attendees) events (4.44 vs. 4.67, $F = 0.72$, $df = 1, 154$, $p = 0.79$). Logistic regression analyses indicated that presentation with an injury compared with non-injury was independently associated with male gender, winter season, and sporting events, even after adjusting for relevant variables.

Conclusions: In this study of low-volume mass gatherings, a similar number of patients sought medical treatment at small (<2,000 patrons) and large (>2,000 patrons) events. This demonstrates that for low-volume mass gatherings, planning based solely on anticipated event size may be flawed, and could lead to inappropriate levels of first-aid coverage. This study also highlights the importance of considering other factors, such as event type and patient characteristics, when determining appropriate first-aid resourcing for low-volume events. Additionally, identification of factors predictive of injury presentations at mass gatherings has the potential to significantly enhance the ability of event coordinators to plan effective prevention strategies and response capability for these events.

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Introduction

Mass gatherings are a common feature of society, and are attended by first-aid providers and other medical personnel as a matter of course. However, little evidence is available to guide event planners about the appropriate numbers and deployment of first aid and medical staff for these events. Typically, these decisions are based on the organizers' experience or historical knowledge,[1] and the adequacy of emergency health provision rarely is evaluated post-event.[2] Much of the existing literature consists of descriptive studies of single events or specific event types.[3–4]

Conflicting definitions of "mass gathering" further complicates the interpretation of available literature. Many studies define events attended by 1,000 people or more as a mass-gathering, whereas others use the definition of crowd size exceeding 25,000.[5] In practice, first-aid coordinators often are responsible for providing first-aid coverage to events which range from several hundred to several thousand people. These smaller events have the potential to generate a considerable workload for first-aid providers. The available literature on patient presentation rates that could be expected at these smaller "mass gatherings" is extremely limited.

Several factors predictive of patient presentation at public events have been identified in the literature. A positive linear relationship between crowd size and the number of patients presenting for treatment has been reported,[6] but other studies have reported an inverse association, with decreasing patient volume associated with increasing crowd size.[7–8] Arbon and colleagues[9] developed a model that identified predictors of patient presentation at events involving in excess of 25,000 patrons. Predictors included crowd mobility; weather conditions; and availability of alcohol. However, it is unclear how applicable these results are to smaller gatherings. Additionally, the ability to accurately predict the type of patient presentation (injury versus non-injury) has the potential to enhance the ability of planners to organize appropriate resources for a given event. Injury presentations commonly are encountered by first-aid providers, and are of particular importance given the potential for prevention. As a consequence, this study focuses on injury presentations.

In Queensland, Australia, coordination of first-aid responses to mass gatherings often is the responsibility of the volunteer organization St John Ambulance Australia. Currently, deployment to events by St John is determined using a 1:2,000 ratio of volunteer ambulance officers to event patrons. No allowance is made for differing crowd sizes, event type, or other variables that may affect patient presentation rate. This workforce allocation ratio never has been formally evaluated.

This study was designed to evaluate a complete sample of volunteer first-aid deployments, including smaller gatherings. There were three primary aims:

1. Describe key patient and event characteristics of medical presentations at a series of mass-gathering events, including events smaller than those previously described in the literature;
2. Determine whether event type and event size affect the mean number of patients presenting for treatment per event, and specifically, whether the 1:2,000 deployment rule used by St John Ambulance Australia is appropriate; and
3. Identify factors that are predictive of injury at mass-gathering events.

Methods

Design

A retrospective, observational, case-series design was used to examine all cases treated by two Divisions of St John Ambulance (Queensland) in the greater metropolitan Brisbane region during a three-year period (01 January 2002–31 December 2004). Brisbane is the capital city of Queensland, and is the largest metropolitan city in the state. The population of the greater Brisbane region was approximately 1.7 million at the time of data collection.[10] In Queensland, emergency medical treatment initiated by a call to emergency services is provided by the Queensland Ambulance Service. As mentioned in the introduction, coordination of first-aid responses to the majority of mass gathering events generally is the responsibility of St John Ambulance Australia, Queensland Division. St John volunteers are trained in the provision of basic first aid. In cases in which transport to a hospital or more advanced prehospital care is required, the Queensland Ambulance Service is contacted.

Data Collection and Variables

Data were obtained from routinely collected patient treatment forms completed by St John Ambulance officers at the time of treatment. These forms contain information on patient demographics, as well as clinical information. St John Ambulance Officers (Queensland Division) are required to complete patient treatment forms for every patient as part of their routine duties. In cases in which transport to hospital via ambulance is required, copies of these patient treatment forms are provided to the Queensland Ambulance Service, and as such, comprise part of the formal patient record. In addition to the patient treatment forms, event-related data were obtained from event reports. The following categorical variables were abstracted from the event reports and included: (1) season (spring, summer, autumn, winter); (2) weather (fine vs. raining); (3) event duration (0–4, 5–8, 9+ hours); (4) environment (inside, outside, both); (5) event size (0–500, 501–2,000, 2,001–5,000, >5,000 patrons); (6) alcohol served (yes, no); (7) food served (yes, no); (8) patron mobility (mobile vs. fixed); (9) number of first-aiders; (10) event type (sporting event, fete/carnival, spectator sport, concert/rave, ceremonial event); (11) patient age (0–16, 17–34, 35+ years); (12) patient gender (male, female); (13) time of presentation (05:01–11:00, 11:01–17:00, 17:01–23:00, 23:01–05:00); and (14) injury status (injury vs. non-injury). Injuries included traumatic complaints. Non-injury presentations included medical complaints such as cardiovascular and respiratory conditions, headaches, heat exhaustion, hypothermia, and emotional and behavioral problems.

Data Processing

Data were processed using SPSS version 15.0 (Chicago, IL, 2006). Different analytic techniques were used for each research question, as described below:

Characteristics of Events

Descriptive analyses of categorical variables were conducted using chi-square tests.

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	Event (n = 156)		Patient Presentations (n = 755)	
	n	%	n	%
Season				
Summer	30	19.2	113	16.0
Autumn	51	32.7	267	37.9
Winter	43	27.6	202	28.7
Spring	32	20.5	123	17.4
Weather				
Fine	140	89.7	620	87.9
Raining	16	10.3	85	12.1
Environment				
Inside	39	25.0	142	20.1
Outside	108	69.2	518	73.5
Both	9	5.8	45	6.4
Event Size				
0–500	71	45.5	375	53.2
501–2000	33	21.2	87	12.3
2001–5000	15	9.6	54	7.7
5000+	37	23.7	189	26.8
Duration				
0–4 hours	48	30.8	134	19.0
5–8 hours	90	57.7	410	58.2
9+ hours	18	11.5	161	22.8
Event type				
Sporting Event	41	26.3	272	38.6
Fete/Carnival	40	25.6	177	25.1
Spectator Sport	16	10.3	53	7.5
Concert/Rave	44	28.2	175	24.8
Ceremonial Event	15	9.6	28	4.0
Alcohol Service				
Yes	58	37.2	288	40.9
No	98	62.8	417	59.1
Food Service				
Yes	87	55.8	424	60.1
No	69	44.2	281	39.9
Patron Mobility				
Fixed	23	14.7	69	9.8
Mobile	133	85.3	636	90.2

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Table 1—Event characteristics

Comparing Mean Patient Presentations by Event Size and Event Type

The outcome measure for these calculations was the mean number of patients presenting for treatment per event. Comparison of the mean number of patient presentations by event size was completed using one-way analysis of variance. Event size data were collapsed into two categories: 0–2,000 patrons, and 2,000+ patrons, in order to examine the utility of the current deployment ratio of 1:2,000 volunteer ambulance officers to event patrons used by St John. Kruskal-Wallis tests were used to compare mean values between event types as the assumption of homogeneity of variance was violated.

Variables Predictive of Injury Status

Injury status was dichotomized (injury vs. non-injury), and a series of crude logistic regressions were performed in order to identify variables significantly associated with injury status. Any variables found to be significantly associated with injury status by the crude analyses were included in a final logistic regression model. Variables that no longer were significantly associated with injury status in this final logistic regression model were successively removed from the model, and the impact on the remaining variables assessed. If the Odds Ratios of the remaining variables changed beyond 10%, the variable was retained in the model. The following variables were retained in the final model: season, event duration, environment, event size, alcohol service, patron mobility, gender, age, time of day, and event type.

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	n	%
Age (years)		
0–16	365	51.8
17–34	243	34.5
35+	89	12.6
Gender		
Female	381	54.0
Male	324	46.0
Time of Presentation		
05:01–11:00 h	118	16.7
11:01–17:00 h	310	44.0
17:01–23:00 h	260	36.9
23:01–05:00 h	17	2.4
Patient Presentation		
Injury	451	64.0
Non-injury	254	36.0

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Table 2—Patient characteristics

Results

Over the three-year study period, St John Ambulance officers treated 705 patients at 156 separate events.

Characteristics of Events

The characteristics of events attended by St John during the data collection period are listed in Table 1. The majority of patient presentations occurred in the autumn or winter (χ^2 = 89.3; *df* = 3; p <0.001), in fine weather (χ^2 = 405; *df* = 1; p <0.001), and in an outdoors setting (χ^2 = 531; *df* = 1; p <0.001). Patients most commonly presented at events lasting 5-8 hours (χ^2 = 197; *df* = 2; p <0.001), where crowd sizes were <2,000 people (χ^2 = 355; *df* = 3; p <0.001), and where the crowd was mobile (χ^2 = 456; *df* = 1; p <0.001). Interestingly, more patients presented at events where alcohol was not served (χ^2 = 23.6; *df* = 1; p <0.001).

Patient characteristics are described in Table 2. Patients were most likely to be <35 years of age (χ^2 = 164; *df*= 2; p <0.001); female (χ^2 = 4.61; *df* = 1; p = 0.032), and to present for treatment during the day (χ^2 = 304; *df* = 3; p <0.001). More patients were treated for an injury than a non-injury (χ^2 = 55.1; *df* = 1; p <0.001).

Comparing Mean Patient Presentations by Event Size and Event Type

The average number of patient presentations at small events (0–2,000 attendees) did not significantly differ from that of large (>2,000) events (4.44 vs. 4.67 presentations per event, F = 0.72; *df* = 1; 154; p = 0.79). Additional (a priori) analyses using more specific event size categories indicated that there may be a U-shape relationship between event size and patient presentations. Mean patient presentations for event sizes were: 0–500 = 5.28; 500–2,000 = 2.64; 2,000–5,000 = 3.60; and 5,000+ = 5.11. The association approached statistical significance, and warrants further investigation (F = 2.49; *df* = 3; 152, p = 0.06).

Mean presentations per event by event type are listed in Table 3. While the mean number of patient presentations appears higher at sporting events than other event types, overall, patient presentations did not differ significantly between event types (χ^2 = 6.1; *df* = 3; p = 0.24; Table 3).

Figure 1 shows the effects of event size and event type on the mean number of patient presentations. The effect of event type on the mean numbers of patient presentations did vary as a function of event size. However, this effect could not be tested for significance, due to the non-normal distribution of the data.

Variables that Predict Injury Status

The likelihood of presenting for treatment of an injury differed significantly as a function of event type (χ^2 = 64.1; *df* = 3; p <0.001). The majority of injuries occurred at sporting events (Table 4.) In addition, injuries were significantly more common at smaller events involving <2,000 patrons (χ^2= 30.5; *df* = 1; p <0.001).

Adjusted analyses indicate that season, gender, and event type were significant independent predictors of an injury presentation, even after the effect of other relevant variables (i.e., event duration, environment, event size, alcohol service, patron mobility, age, and time of day) were taken into account (Table 5). Males were three times more likely to present with an injury than females (OR = 3.01; 95% CI = 2.1–4.3). Injuries were significantly more common in winter than during any other season (OR = 1.81; 95% CI = 1.03–3.2), and were almost five times more likely to occur at sporting events than during other event types, such as spectator and ceremonial events (OR = 4.91; 95% CI = 1.9–12.4).

Discussion

Presentations during low-volume mass-gathering events in which first aid was managed by a volunteer-based organization (St John Ambulance Australia) during 2002–2004 differed significantly according to event type and other patient characteristics, but not by event size. The events in this study typically involved a small crowd size (<500 patrons), where patrons were mobile, and where alcohol was not served. Sporting events were the most common event type. There were more patient presentations per event during colder months (autumn and winter), at outdoor events, and in fine weather.

The mean number of patient presentations per event was similar for larger and smaller events, using the definitions that guide current deployment strategies of many volunteer organizations (i.e., 1:2,000 patrons per volunteer). This finding is perhaps counter-intuitive, as it could reasonably be expected that larger events would result in a higher caseload. However, an inverse association between event size and patient presentation has been reported previously.[7–8] Arbon and colleagues demonstrated a positive association between event size and presentation rate.[6] However, this model was based on events where the crowd size exceeded 25,000 people. In the current study, only one-quarter of events involved a crowd size >5,000 patrons, and two-thirds of events attracted <2,000 patrons.

The ability to generalize the current findings to larger mass gatherings (5,000+) is limited, for two reasons: (1) analyses were limited by the data collected routinely by St John, and

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Event type	Mean Presentations per Event	Median Presentations per Event	Standard Deviation	Number of Events
Sporting Event	6.59	4	7.1	41
Fete/Carnival	4.18	2	4.8	40
Spectator Sport	3.50	3	2.7	16
Concert/Rave	4.09	3	3.8	44
Ceremonial Event	2.13	2	1.4	15

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Table 3—Mean patient presentation per event by event type (n = 156)

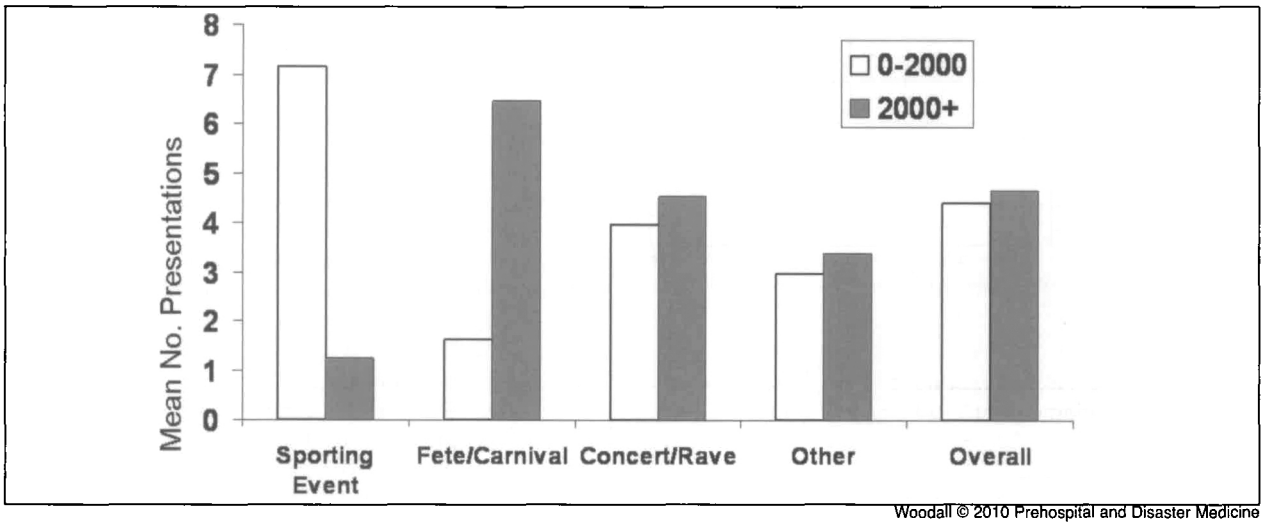

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Figure 1—Mean of the numbers of patients presenting for treatment

	Injury n (%)	Non-Injury n (%)
Event type		
Sporting Event	223 (31.6)	49 (6.9)
Carnival/ Fete	93 (13.2)	84 (11.9)
Concert/ Rave	97 (13.8)	78 (11.1)
Other	38 (5.4)	43 (6.1)
Event Size		
0–2,000	329 (46.7)	133 (18.9)
2,001–5,000+	122 (17.3)	121 (17.1)

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Table 4—Injury presentation by event type and event size (n = 705)

	OR	95%CI
Season		
Summer	0.56	0.3–1.1
Autumn	0.74	0.4–1.3
Winter	1.81	1.03–3.2*
Spring	--	
Gender		
Male	3.01	2.1–4.3
Female	--	
Event type		
Sporting Event	4.90	1.9–12.4
Carnival/ Fete	1.23	0.5–3.1
Concert/ Rave	1.53	0.6–4.3
Other	--	

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Table 5—Significant independent predictors of injury
Note: The model is adjusted for: event duration, environment, event size, alcohol service, patron mobility, age, and time of day.
*$p = 0.03$

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the categories used to describe group size (i.e., the largest category was 5,000+); and (2) the majority of the events attended in this study were relatively small (<500). The apparent U-shape association between event size and mean presentations per event warrants further investigation.

While care should be taken in applying this finding to other settings, this research demonstrates that smaller mass gatherings have the potential to produce a considerable caseload. In some cases, it may be appropriate to deploy equivalent first-aid resources to large and small events, but it is important to include other factors to accurately inform resource deployment models. For instance, six presentations across a five-hour period event may seem manageable for two first-aid staff. However, difficulties may arise if these presentations coincide. Further investigation is required regarding the association between patient presentations and the "stages" of an event (i.e., patron arrival, intermission, departure).

Event type did not affect the mean number of patient presentations per event. While more patients presented for treatment at sporting events, this difference was not statistically significant. Further research is warranted to evaluate the severity of cases treated at different event types. This study only assessed incidence and did not take into account the important resource implications of serious versus minor conditions.

It was not possible to test for an interaction effect between event type and size, due to limitations of the data. However, these results indicate that the higher rate of patient presentation observed at small events may largely be due to the event type being sporting events. Furthermore, patients at sporting events were almost five times more likely to present with an injury than patients at spectator sports or ceremonial events. As such, it may be especially important to ensure adequate staff coverage at these events.

In this study, logistic regression analyses identified a number of independent predictors for injury at mass gatherings. This differs to previously published research in which predictors of general presentation rate (injury, in addition to other medical presentations) were investigated.[9] In the current study, increased risk of injury (compared with other presentation types) was associated with sporting events, male gender, and events held during winter even after adjusting for other relevant variables. A relationship between cooler weather and fracture risk has been reported,[11–12] however, this finding was reported in relation to elderly patients, and not the typically young patients studied in the current sample. In addition, Brisbane experiences more temperate weather than the study populations described in the literature. Of interest is that alcohol service was not independently associated with injury. The positive association between alcohol and injury has been well described.[13–15] It is possible that the variable used to define alcohol service in the current study did not accurately capture alcohol consumption, and that patients consumed alcohol even at events where it was not served by the event organizers.

This study provides support for considering small sporting events as high-risk events for injury. These data indicate that St John first-aiders attended to more patients at sporting events, and that injury was more common at these events than during other event types. Because community sporting events tend to involve small crowd sizes, traditional staff deployment models may result in such events being under-resourced. Further research is warranted to determine if specific high-risk sporting events can be identified to better inform deployment models.

Limitations

This study has several limitations. First, data were collected from a single location (Brisbane, Australia). It is possible that data from other settings may yield different results. Second, the data set did not include many of the variables known to influence injury risk (e.g., activity at time of injury, risk perception, education, occupation, salary, etc.).[16–17] This highlights the importance of replicating the current study with a prospective design, to allow for more sophisticated analyses. Third, as discussed above, the ability to generalize the current findings to mass gatherings >5,000 patrons is limited, as most of the events included in this data set involved <2,000 patrons. However, this also may be considered a strength of the current study, as there is very little published data on the characteristics of events and patients who present for treatment at smaller mass gatherings. Fourth, there was no information available to verify the ascertainment rate of the sample. It is possible that patient treatment forms may not have been completed for all patients, and that not all patient treatment forms were 100% complete. However, St John Ambulance Officers (Queensland Division) are required to complete patient treatment forms for every patient as part of their routine duties. Therefore, it can be reasonably assumed that the number of missed patients and missing data is minimal. Finally, data in this study were obtained from event forms routinely used by St John Ambulance in Queensland. For instance, the measure for event size was crude, as it relied on the categories: 0–500; 501–2,000; 2,001–5,000; and 5,000+. Other variables that would have been a useful addition to the interpretation of the analyses were, therefore, also not collected—for example, demographic patterns of patron attendees (vs. patients treated by St John), and whether treated patients were participants or spectators at the event. The measures available for analyses consequently limit the conclusions and comparability with previously published literature.

Conclusions

A key finding of this study on low-volume mass gatherings is that small events (<2,000 patrons) produce a similar number of patients seeking medical treatment as larger events (>2,000 patrons). Low volume mass gatherings should be considered a legitimate field of research. Planning based solely on anticipated event size may be flawed and could lead to inappropriate levels of first-aid coverage. Community sporting events, in particular, can result in high injury caseloads, indicating the importance of considering the type of mass gathering and resultant medical conditions when determining appropriate first-aid resourcing for smaller events. Further research (ideally, a prospective study) is required to confirm this finding, to identify characteristics of smaller mass gatherings that may produce excess caseload, and to study the severity of cases treated at these types of events.

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