

Mass-gathering Medicine: Risks and Patient Presentations at a 2-Day Electronic Dance Music Event

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Conflict of interest: Both authors have participated at events as volunteers and in contracted or honorarium-based roles as operational and clinical care providers.

Keywords: electronic dance music event; hazard; mass gathering; music festival; risk

Abbreviations:

ATR: ambulance transfer rate
ED: emergency department
EDME: electronic dance music event
FA: first aid
FAA: first aid attendant
HLC: higher level of care
PEF: patient encounter form
PPR: patient presentation rate
UBC: University of British Columbia

Received: November 12, 2014

Revised: February 3, 2015

Accepted: February 21, 2015

doi:10.1017/S1049023X15004598

Online publication: April 14, 2015

Abstract

Introduction: Music festivals, including electronic dance music events (EDMEs), increasingly are common in Canada and internationally. Part of a US \$4.5 billion industry annually, the target audience is youth and young adults aged 15-25 years. Little is known about the impact of these events on local emergency departments (EDs).

Methods: Drawing on prospective data over a 2-day EDME, the authors of this study employed mixed methods to describe the case mix and prospectively compared patient presentation rate (PPR) and ambulance transfer rate (ATR) between a first aid (FA) only and a higher level of care (HLC) model.

Results: There were 20,301 ticketed attendees. Seventy patient encounters were recorded over two days. The average age was 19.1 years. Roughly 69% were female (n = 48/70). Forty-six percent of those seen in the main medical area were under the age of 19 years (n = 32/70). The average length of stay in the main medical area was 70.8 minutes. The overall PPR was 4.09 per 1,000 attendees. The ATR with FA only would have been 1.98; ATR with HLC model was 0.52. The presence of an on-site HLC team had a significant positive effect on avoiding ambulance transfers.

Discussion: Twenty-nine ambulance transfers and ED visits were avoided by the presence of an on-site HLC medical team. Reduction of impact to the public health care system was substantial.

Conclusions: Electronic dance music events have predictable risks and patient presentations, and appropriate on-site health care resources may reduce significantly the impact on the prehospital and emergency health resources in the host community.

Lund A, Turriss SA. Mass-gathering medicine: risks and patient presentations at a 2-day electronic dance music event. *Prehosp Disaster Med.* 2015;30(3):271-278

Introduction

Music festivals, including electronic dance music events (EDMEs), are increasingly common. Since the 1980s, with breakthroughs in the technologies supporting electronically engineered music, the growth of EDMEs has been exponential internationally. Part of a US \$4.5 billion industry annually, the target audience is youth and young adults aged 15-25 years.¹⁻⁵

Raves, the origin of the EDME movement, are all night dance parties featuring electronic music, typically held in venues not intended for that purpose.⁵ Raves occurred "underground" in venues not intended for large crowds or purpose built for events; admission charges were often low (eg, US \$5).⁶ Electronic dance music events were created as the rave music scene moved out of the underground and into licensed establishments.⁷⁻⁹ At the present time, with special event infrastructure including alcohol sales, security, toilets, catering, and health services, admission charges can run to over US \$100 per day.⁸

Documented risks of EDMEs include: alcohol overuse;⁷ drug use;^{8,10,11} drug overdoses related to the use of 3,4-methylenedioxy-N-methylamphetamine and related compounds, gamma-hydroxybutyric acid,¹² as well as other drugs;¹³ driving accidents;⁸ and mass-casualty incidents.¹⁴ Music festivals may be higher risk than other types of events that involve young people gathering in large numbers. Over the last 15 years, mainstream media sources have reported at least 68 deaths attributed to drug overdoses/poisonings in the

Year	Name of Event	City, State/Country	Age(s)	Deaths	Reference
2014	Hard Summer Festival	Los Angeles, California USA	19	1	[15]
2014	Boonstock Music and Arts Festival	Penticton, Canada	24	1	[16]
2014	VELD Festival	Toronto, Canada	22, 22	2	[17]
2014	Sun God Fest	San Diego, California USA	20	1	[18]
2014	Pemberton Music Festival	Pemberton, Canada	21	1	[19]
2014	Escapade Music Festival	Ottawa, Canada	19	1	[20]
2014	Mad Decent Party	Baltimore, Maryland USA	20, 17	2	[21]
2014	Glastonbury Festival	Glastonbury, UK	26	1	[22]
2014	Electric Forest Festival	Rothbury, Michigan USA	20	1	[23]
2014	Electric Daisy Carnival	Las Vegas, Nevada USA	25, 24	2	[24]
2014	Illegal Rave	London, UK	15	1	[25]
2014	Ultra Music Festival	Miami, Florida USA	21	1	[26]
2014	Future Music Festival	Kuala Lumpur, Malaysia	22, 26, 21, 28, 23, 27	6	[27]
2014	Illegal Rave	London, UK	16	1	[28]
2013	Echo Stage Rave	Washington DC, USA	19	1	[29]
2013	Electronic Zoo Festival	New York, New York USA	23, 20	2	[30]
2013	Defquon Music Festival	Sydney, Australia	23	1	[31]
2013	Zedd Music Festival	Boston, Massachusetts USA	19	1	[29]
2013	Governor's Island Rave	Governor's Island, New York USA	20	1	[29]
2013	Paradisio Festival	Quincy, Washington USA	20	1	[32]
2013	Ultra Music Festival	Miami, Florida USA	20	1	[26]
2013	Life in Color	Kingston, Rhode Island USA	18	1	[33]
2012	Voodoo Festival	Little Rock, AK USA	21	1	[34]
2012	Shambhala Music Festival	Trail, Canada	23	1	[35]
2012	V Festival	Chelmsford, UK	39	1	[36]
2012	V Festival	South Staffordshire	22	1	[36]
2012	Identity Festival	Rhode Island, USA	19, 27	2	[37]
2012	Global Gathering Festival	Stratford-upon-Avon, UK	24	1	[36]
2012	Electric Forest Festival	Rothbury, Michigan USA	37	1	[38]
2012	Electric Daisy Carnival	Las Vegas, Nevada USA	22, 31	2	[15]
2012	Rockness Music Festival	Lock Ness, UK	19	1	[39]
2012	Kapolei Rave	Honolulu, Hawaii USA	19	1	[40]
2012	Nocturnal Wonderland	Milam County, Texas USA	32	1	[38]
2011	Alexandra Palace Rave	London, UK	21, 22	2	[41]

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Table 1. Overdose/Poisoning-related Fatalities at Music Festivals (*continued*)

Year	Name of Event	City, State/Country	Age(s)	Deaths	Reference
2011	Afterlife Rave	Dallas, Texas USA	19	1	[15]
2011	Boonaroo Music Festival	Manchester, Tennessee USA	24, 32	2	[42]
2011	Electric Daisy Carnival	Dallas, Texas USA	19, 22	2	[38]
2010	Electric Daisy Carnival	Dallas, Texas USA	22	1	[43]
2010	Electric Daisy Carnival	Los Angeles, California USA	15	1	[38]
2010	Bonnaroo Music Festival	Manchester, Tennessee USA	29	1	[42]
2010	Pop2010	San Francisco, California USA	23, 25	2	[44]
2010	Together as One	USA	24	1	[38]
2009	Nocturnal Festival	USA	23	1	[38]
2009	Big Day Out	Perth, Australia	17	1	[45]
2009	Kendall Calling Festival	Cumbria, UK	20	1	[46]
2008	Monster Massive	Anaheim, California USA	23	1	[38]
2008	Coachella Valley Music & Arts Festival	Indio, California USA	21	1	[47]
2008	Together as One	Los Angeles, California USA	23	1	[38]
2007	Monster Massive	Los Angeles, California USA	20	1	[15]
2006	Nocturnal Wonderland	San Bernardino, California USA	18	1	[38]
2004	Bonnaroo Music Festival	Manchester, Tennessee USA	22, 20	2	[42]
1999	Hullaballo Festival	Toronto, Canada	21	1	[48]
Total:				68	

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Table 1 (*continued*). Overdose/Poisoning-related Fatalities at Music Festivals

context of music festival attendance (Table 1).¹⁵⁻⁴⁸ The true extent of the mortality burden is currently unknown. Non-substance related deaths (ie, homicides, drowning, and trauma) were excluded from analysis.

Accordingly, emergency physicians are becoming increasingly familiar with the type of patient presentations associated with large EDMs. Health care professionals involved in the provision of on-site care at large music festivals and EDMs experience first-hand the range of clinical presentations at these events, and researchers are just beginning to document the illness/injury burden and case-mix associated with this category of event.^{3,5,7,8,10-12,49,50} Because of risk profile of EDMs, on-site medical care is sometimes provided and various authors have argued that health services should be on site;⁵¹ however, little is known about the impact of different models of on-site care, ranging from first aid (FA) only to higher level of care (HLC) multidisciplinary teams, which may include advanced care paramedics, nurses, psychiatric nurses, drug counselors, nurse practitioners, physicians, and others.

Given substantial acute care costs, an international problem with emergency department (ED) overcrowding,⁵²⁻⁵⁶ ambulance offload delay, and ever increasing numbers of ED visits, the authors of this study wondered about the degree to which mass gatherings in general, and EDMs in particular, impact the health care system.

Lund, Turrís, and Bowles recently published on the consumptive and disruptive effects of mass gatherings on baseline health care services.⁵⁶ The present report is an extension of that work.

The authors hypothesized that the on-site presence of a team of HLC providers (including emergency physicians) would mitigate the impact on local EDs since appropriate patients could be assessed, treated, and monitored on site while they recovered from the effects of mild to moderate overuse of alcohol or recreational drugs.

Research Question(s)

In the present study, the authors investigated the following questions:

1. On site, what are the case mix (including acuity) and patient presentation rates (PPRs) per 1,000 attendees?
2. What are the ambulance transfer rates (ATRs) per 1,000 attendees for both a FA model and a HLC model (ie, clinical monitoring, diagnostic decision making, and critical care experience)?

Methods

Outcomes of interest for this study included: PPRs, case mix, medical interventions required, and ATRs.

Case Mix and Patient Presentation Data

Data for this study were drawn from the University of British Columbia (UBC) Event and Patient Registry, out of the Department of Emergency Medicine at UBC.⁵⁷ Ethics approval was obtained through the UBC Research Ethics Board.

During the event, documentation (ie, patient encounter form [PEF]) was reviewed by researchers on site (ST and AL) in a timely fashion. As each form was completed (ie, upon discharge or transfer of the patient), it was reviewed, missing fields (if applicable) were identified, and the form was returned immediately to the provider for completion.

Registry data were extracted from PEFs on an ongoing basis throughout the event. Data were entered by volunteer medical students who received a standardized orientation to data entry and were overseen directly by a research program manager (KL) familiar with the architecture and unique fields of the Registry.

Inclusion and Exclusion Criteria

Cases were included if an individual presented for medical care to the main medical tent on site at the event. Cases were excluded if individuals presented to the main medical tent for reasons other than health care issues (ie, directions or looking for a friend).

Ambulance and Transfer to Hospital Avoidance

Determination regarding disposition (ie, hospital transfer or treat and release) was made on a case-by-case basis and data about the disposition were recorded as described below:

1. First aid attendants (FAA), first contact on all patients at the event, assessed each patient and determined whether s/he was “first aid only” or required HLC.
2. All patients beyond FA “treat and release” were vetted through an on-site HLC team, which was co-located with standby ambulance resources.
3. The most responsible health care provider for each patient (ie, FAA, nurse, nurse practitioner, or physician) indicated in a data field on the PEF whether or not the care provided at the event prevented transfer to the hospital for additional care.
4. All transports were coordinated through the HLC team and on-site ambulance command.

Results

Event-related Variables

Ticket costs (regular/VIP) were US \$125/\$190 for a single day or US \$220/\$270 for both days. On the first day, attendees were in line for up to four hours prior to entering the venue due to security screening procedures. The temperature outside was 4.6°/4.9° Celsius (40.3°/40.8° F), the weather was overcast, and attendees were “in costume” (ie, many were underdressed for the ambient temperatures).⁵⁸

The venue for the 2-night EDME was covered and bounded and took place in a large Canadian city. For the present event, the floor of the 50,000+ person venue was overlaid with interlocking, plastic, flexible flooring. The event took place primarily on a 15,000 square foot floor and there were four half-sections of seating open to the spectators (just under 3,000 seats). Spectators on the floor were standing or dancing; no seating was available on the floor.

The lighting was low, with the exception of stage show lighting in the blue and green color spectrum and intermittent strobe

Role	Day 1	Day 2
Physicians/Nurse Practitioners	4	5
Nurses	5	9
First Aid	22	24
Learners (multidisciplinary)	8	15
Totals	39	53

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Table 2. On-site Health Care Providers^a

^aExcludes operations/logistics/communications staff.

lighting, which made the preservation of night vision impossible. Sound regularly registered at 95–100 decibels on the floor. Fog was present intermittently throughout the event, generated by the event special effects team.

Alcohol was available on an “open carry” basis (ie, one drink at a time sold to individuals 19 years of age or older and exhibiting no evidence of intoxication). Food was available for purchase on site, and potable water was available from venders roaming the floor, in vending machines, and from bathroom taps.

In terms of venue health and safety services, certified FA services were on site, consisting of providers operating out of a permanent purpose-built FA room located within the building in the outer ring of the venue, adjacent to the event. An additional contracted team of HLC providers (Table 2) was on site in a temporary clinic setting on a loading dock within the venue, adjacent to the event floor. Contracted stand-by paramedics staffed the event with three stand-by ambulances (including one non-transport equipped ambulance geared for event communications and logistical support). Additional police were on site, as were venue and additional contracted security services.

Patient-related Variables

The 2-day event drew thousands of attendees on both nights. The demographics of patient groups on Day 1 and Day 2 were similar, as were the PPRs and the ATRs. Females presented more commonly than males. The number of under-aged patients (ie, less than 19 years of age) was slightly higher on the second night. Patient demographics, PPRs, and ATRs are reported in Table 3.

For the HLC team, the majority of patient encounters (n = 55/70; 79%) involved assessment and treatment for drug and alcohol overuse. Dimenhydrinate (n = 14) was the most common medication administered (Day 1, four doses given by injection, one dose intravenously; Day 2, three doses orally, two doses by injection, and four doses intravenously). Acetaminophen (n = 1), lorazepam by injection (n = 1), and ibuprofen (n = 1) were also given. A total of nine intravenous starts for volume or parenteral access were required (Day 1, n = 3; Day 2, n = 6).

Ambulance transfer and ED avoidance were determined when a patient who would have been transferred in a FA only model was transferred to the HLC team, and the HLC team was able to provide the required level of care on site, most commonly, pending patients' recovery from the acute effects of alcohol and/or substance use. Of note, the last two transfers each night occurred because less than an hour of on-site medical coverage remained and the patients were judged to need more than an hour to recover

Variable	Day 1	Day 2	Total
Total Attendance	9,636	10,665	20,301
Total Patients	38	45	83
First Aid Only	7	6	13
Higher Level Care	31	39	70
Mean Age (range)	19.8	18.6	19.1 (15-34)
Under Age 19 in HLC	12 (39%)	20 (51%)	32 (46%)
Females in HLC	23 (74%)	25 (64%)	48 (69%)
Mean Length of Stay in HLC Area (minutes)	61	78	71
Patient Presentation Rate ^a	3.94	4.22	4.09
Ambulance Transfers Averted	13	16	29
Total Transfers to ED	5	6	11
Ambulance Transfer Rate ^a			
First Aid Only Model	1.87	2.06	1.98
Actual with HLC	0.52	0.56	0.54
Transfer Rate Reduction	72.2%	72.7%	72.5%

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Table 3. Demographics, Case Mix, PPR, ATR, and Ambulance Transfers Avoided

Abbreviations: ATR, ambulance transfer rate; ED, emergency department; HLC, higher level of care; PPR, patient presentation rate.

^aPer 1,000 attendees at event.

from the effects of alcohol and substance overuse (Table 4). For each transfer to the hospital, a phone report was called to the receiving ED and a copy of patient documentation was sent with the patient, accompanied by paramedics.

Venue FA staff called no ambulances due to the on-site presence of the HLC team. Venue FA staff reported they would not have the capacity or mandate (eg, space, personnel, or policies) to “watch and wait” for the resolution of symptoms in a large number of patients with decreased levels of consciousness. Therefore, in the absence of the HLC team, they would have called emergency services (eg, 911 or equivalent service) for patients who were not “treat and release.” The presence of an on-site HLC team had a significant positive effect on avoiding ambulance transfers.

The majority of patients seen were able to return to the event after being assessed, treated, and observed (Table 5). Those who returned to the event were discharged in the care of a responsible (ie, non-intoxicated) friend or parent; patients who returned to the event were encouraged to come back to the medical clinic on an as-needed basis. No patients seen returned for a second encounter with the HLC team.

Discussion

Patient Presentation Rates, Case Mix, and Health Services Utilization

Mass gatherings in general, and EDMEs in particular, can have a substantial impact on the local health care system. There are scant reports in the medical literature regarding EDMEs, yet

deaths and adverse outcomes are published repeatedly in the media.¹⁵⁻⁴⁸ In the context of an EDME, Molloy and colleagues documented 39 ED visits in a 24-hour period, requiring nine admissions, two readmissions, and 25 interventions, including intravenous fluids, suturing, joint reductions, and casting. Violence at this event also resulted in eight stabbings, four of which required chest tubes. There were two deaths associated with this event.⁵⁰

Drug and Alcohol Use

Recreational drug and/or alcohol use was a factor in 79% of cases (55/70) in the present study. Similarly, a retrospective review of ED visits related to a large summer music festival in Ireland documented a 94% incidence of alcohol and/or drug use as a co-factor for patients transferred to the ED from a music festival. In contrast, Krul collected data prospectively, over a 4-year period, from a series of indoor and outdoor EDMEs in the Netherlands.⁵⁹ He reported just over one-quarter of patient presentations were related to recreational drug use.

The difference in reported rates of drug and alcohol use is stark. It is possible that attendees in the Netherlands did not disclose drug or alcohol use, or it was not captured as an independent variable in the charting. Further, as the present study occurred at an indoor venue, it is possible that there were fewer “simple first aid” presentations (ie, heat exposure, sunburns, wounds, and insect envenomations) that are common in outdoor, multi-day festival environments.

Day 1		
Transfers	Age and Gender	Indication for Transport
Case 1	17 year old woman	Alcohol (ETOH) on board; disoriented, combative.
Case 2	28 year old woman	ETOH on board; lost her balance and fell down seven stairs; presented with facial abrasions and a Glasgow Coma Scale (GCS) of 15/15; subsequently became obtunded with a GCS of 9.
Case 3	19 year old woman	Intoxicated; fell down stairs; decreasing level of consciousness.
Case 4	21 year old woman	ETOH on board; found unresponsive; not rousing with time.
Case 5	20 year old man	Agitated, uncooperative; tachycardic with a heart rate of +150 beats per minute who presented stating "I think I am going to die."
Day 2		
Transfers	Age and Gender	Indication for Transport
Case 1	15 year old man	Bruxism, not waking up after 45 minutes of observation and supportive care.
Case 2	16 year old man	GHB and MDMA overuse; not protecting his airway reliably.
Case 3	17 year old woman	Decreased GCS and airway issues.
Case 4	18 year old woman	Intoxicated, combative.
Case 5	19 year old woman	Polysubstance use; not waking.
Case 6	unknown age man	Polysubstance use; not waking.

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Table 4. Details of Transfer to Hospital Cases

Abbreviations: ETOH, alcohol; GCS, Glasgow Coma Scale; GHB, gamma-hydroxybutyric acid; MDMA, 3,4-methylenedioxy-N-methylamphetamine.

Variable	Day 1	Day 2	Total
Return to Event	22 (58%)	23 (51%)	45
Home/Hotel	11 (29%)	16 (36%)	27
Hospital (Ambulance)	5 (13%)	6 (13%)	11
Total Patients	38	45	83

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Table 5. Patient Disposition

More likely, the difference may have been due to the practice of "preloading" with alcohol (ie, drinking before entering the event grounds).⁶⁰ Similarly, Merlo and colleagues described "tail gating," which involves drinking in the parking lot before attending a dry college football game.⁶¹ Preloading and tailgating may be a risk for under-agers who would have a more difficult time obtaining alcohol within the venue.

Ambulance Transfer and ED Visit Avoidance

There is increasing support for mandating on-site medical teams at events.^{60,61} In the present study, hospital referrals occurred at a rate of 13.3% of patients presenting to the HLC medical team. In terms of reducing ATRs, a single study was identified. Dutch and Austin described the deployment of a HLC team for a series of EDMEs in Australia. They reported on 61 cases of gamma-hydroxybutyric acid intoxication and found a 64% reduction in

ambulance transfers to hospital due to the HLC team, which is similar to the 72.5% rate reported in the present study.⁴⁹

Recommendations

Based on the results of this study, the authors recommend:

1. **Replication Using a Control Group:**
The present study provides a "snap shot" of a single EDME. Examination of a series of similar events, employing a cohort or control group design, would allow researchers to explore prediction models vis a vis clinical presentations and health care burden.
2. **On-site Medical Teams:**
Electronic dance music events can have an impact on the Emergency Medical Services and EDs in the host community. On-site support with safe monitoring capacity for mild to moderately intoxicated individuals may reduce the rate of transport and the number of ED visits. Further research is required to confirm the optimum mix of providers to meet the need, while remaining cost effective. Medico-legal risk and responsibility for non-transport decisions requires further exploration and discussion. Prospective trials of "event observation medicine" protocols with clear inclusion and exclusion criteria for mild to moderately intoxicated patients would improve the evidence base for this practice.
3. **Measurement of Health Care Burden:**
Outcomes for patients who were transferred to a hospital were not explored in the present study. A robust model for

No access to venue if intoxicated prior to entry.
Efficient check-in, avoiding long queues.
Water available freely.
Consider drug testing on site (ie, testing drugs to confirm constituents).
Peer support on site.
"Chill-out zone" for attendees (safe place for those having a dysphoric drug reaction after medical clearance).
Watch and wait zone – letting attendees "sleep it off" in a safe environment.
Having security check on people who appear to be asleep.

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Table 6. Harm Reduction Strategies^{9,59,63-66}

quantifying the cost of an ED visit in this context, as well as an analysis of the costs of mounting a medical response on site during events, is a next logical step in understanding and describing the full scope of the impact on local health services.

- Institute Consistent Harm Reduction Strategies: Emergency physicians who provide care at EDMs and are keen to reduce the number of hospital referrals (with the resulting cost savings to the system) could consider integrating harm reduction suggestions reported in the literature (Table 6). Of note, these are suggestions; to the authors' knowledge, none of the interventions have been tested prospectively for efficacy.
- Reduce ED Visits by Designing Safer Events: Various researchers, with an interest in harm reduction, are exploring the culture of particular types of mass gatherings, as well as the behavior of audience members at specific types of planned events.⁶² "Crowd resiliency" is discussed increasingly in the literature as one way of focusing attention on supporting those attending and participating in events to stay safe (eg, advocating for friends to "stay together," "never put down your drink," and even selling kits to test drugs to confirm content prior to ingestion).⁶³⁻⁶⁶

Limitations

The current study presents descriptive data from a single event. Decisions regarding transport were made according to the

professional judgment of the physician at the bedside, in consultation with an on-site emergency physician. Patient and transport data from events with a FA only model would be valuable to understand the transfer rates without the presence of a HLC team. Prospective replication, including the use of a control group, is required to confirm (or refute) and further clarify the effects of a HLC team on patient transport rates. Other impacts, such as dispatch delay, ambulance response times, crew on-scene times, off-load delay in hospital, and ED data, are not addressed in this study.

Conclusions

Electronic dance music events have a predictable need for on-site medical services, including the ability to care for patients with altered levels of consciousness, intoxication, and potential airway compromise. In the present study, the introduction of clinical monitoring by a HLC team reduced the need to transfer patients with altered levels of consciousness. Investment by event producers in robust, on-site FA and HLC medical response decreased the impact of this category of mass gathering on its host community by reducing the number of ambulance transfers.

Acknowledgements

The authors would like to acknowledge Ms. Kerrie Lewis, Mr. Jordan Myers of Warehouse Productions, Ltd, Dr. Samuel J. Gutman of Rockdoc Consulting, Inc, and Masoud Yousefi, Senior Statistical Analyst, Vancouver Coastal Health Research Institute.

References

- Carmichael T. Electronic dance music (EDM) fan behavior differs greatly from that of other music fans. *Marketwired*. Published June 17, 2013. <http://finance.yahoo.com/news/electronic-dance-music-edm-fan-192420959.html>. Accessed February 24, 2014.
- Mason K. The beat generation: electronic dance music emerges as the sound of young America. Billboard Web site. Published December 11, 2011. <http://www.billboard.com/articles/news/464794/the-beat-generation-electronic-dance-music-emerges-as-the-sound-of-young>. Accessed February 24, 2014.
- Ter Bogt TFM, Engels RCME. Partying hard: party style, motives for, and effects of MDMA use at rave parties. *Subst Use Misuse*. 2005;40(9-10):1479-1502.
- Watson K. International Music Summit. IMS Business Report 2013. Published May 2013. http://www.internationalmusicsummit.com/img/stand_alone_files/file/original/ims-business-report-2013-final2-10.pdf. Accessed February 24, 2014.
- Weir E. Raves: a review of the culture, the drugs, and the prevention of harm. *CMAJ*. 2000;162(13):1843-1848.
- Madert K. The rise of electronic dance music: an in-depth look at the current state of EDM. Unpublished thesis. 2013;1-43.
- Johnson MB, Voas RB, Miller BA. Driving decisions when leaving electronic music dance events: driver, passenger, and group effects. *Traffic Inj Prev*. 2012;13(5):577-584.
- Furr-Holden D, Voas RB, Kelley-Baker T, Miller B. Drug and alcohol-impaired driving among electronic music dance event attendees. *Drug Alcohol Depend*. 2006;85(1):83-86.
- Chinet L, Stephan P, Zobel F, Halfon O. Party drug use in techno nights: a field study among French-speaking Swiss attendees. *Pharmacol Biochem Behav*. 2007;86:284-289.
- Johnson MB, Voas RS, Miller BA, Holder HD. Predicting drug use at electronic music dance events: self-reports and biological measurements. *Eval Rev*. 2009;33(3):211-225.
- Van Haver T, Vanderpalasschen W, Lammertyn J, Broekaert E, Bellis M. Drug use and nightlife: more than just dance music. *Subst Abuse Treat Prev Policy*. 2011;6:1-18.
- Box SA, Prescott LF, Freestone S. Hyponatremia at a rave. *Postgrad Med J*. 1997;78(885):53-54.
- Britt G C, McCance-Katz EF. A brief overview of the clinical pharmacology of "club drugs." *Subst Use Misuse*. 2005;40(9-10):1189-1201.
- Soomaroo L, Murray V. Disasters at mass gatherings: lessons from history. *PLOS Currents*. 2012;4:1-12.
- Romero D. 10 raver deaths in 5 years. *LA Times Weekly* online. Published June 20, 2012. <http://www.latimes.com/informer/2012/06/20/10-raver-deaths-in-5-years-ecstasy-often-blamed?page=10>. Accessed September 8, 2014.
- Woodward J. Boonstock festival goer died on birthday trip. *CTV News Vancouver*. Published August 4, 2014. <http://bc.ctvnews.ca/boonstock-festivalgoer-died-on-birthday-trip-1.1946025>. Accessed September 15, 2014.
- Fatima A. Drug related deaths at Toronto's VELD Festival prompt homicide investigation. *The Globe and Mail* online. Published August 4, 2014. <http://www.theglobeandmail.com/>

- news/toronto/siu-investigating-death-of-concert-goer-handcuffed-by-police/article19906816/. Accessed September 1, 2014.
18. Perry T. USD student dies of drug overdose after on campus music festival. *LA Times* online. Published August 20, 2014. <http://www.latimes.com/local/lanow/la-me-ln-ucsd-student-drug-overdose-20140820-story.html>. Accessed September 10, 2014.
 19. Humphries A, Hudes S. Who were the young people who died apparently from tainted drugs at music festivals? *National Post* online. Published August 6, 2014. <http://news.nationalpost.com/2014/08/06/who-were-the-young-people-who-died-apparently-from-tainted-drugs-at-music-festivals/>. Accessed September 9, 2014.
 20. Bell D. Woman dies at Ottawa rave event; 2nd woman in coma. *Ottawa Sun* online. Published July 4, 2014. <http://www.ottawasun.com/2014/07/04/woman-dies-at-ottawa-rave-event-2nd-woman-in-coma>. Accessed September 1, 2014.
 21. Rettig J. 2 dead, 20 hospitalized after Mad Decent Party. *Sterogram* online. Published August 4, 2014. <http://www.sterogram.com/1696252/2-dead-20-hospitalized-after-mad-decent-block-party/news/>. Accessed September 1, 2014.
 22. Dearden L. Glastonbury 2014: reveller dies in hospital after taking Ketamine. *The Independent* online. Published June 27, 2014. <http://www.independent.co.uk/arts-entertainment/music/news/glastonbury-festival-2014-reveller-dies-in-hospital-after-taking-ketamine-9568197.html>. Accessed September 15, 2014.
 23. Agillfillan. Death reported at Electric Forest Music Festival. *Fox News West Michigan* online. Published June 30, 2014. <http://fox17online.com/2014/06/30/death-reported-at-electric-forest-music-festival/>. Accessed September 10, 2014.
 24. Young A. Second person dies at Electric Daisy Carnival 2014, marks seventh death since 2011. *Consequence of Sound* online. Published June 24, 2014. <http://consequenceofsound.net/2014/06/second-person-dies-at-electric-dance-carnival-2014-marks-seventh-death-since-2011/>. Accessed September 15, 2014.
 25. Anonymous. Tributes to Rio Andrew who died after Croydon Rave. *BBC News London* online. Published June 17, 2014. <http://www.bbc.com/news/uk-england-london-27884915>. Accessed September 1, 2014.
 26. Yosh A. Two possible deaths at Ultra Music Festival this year; 2013 death attributed to bath salts. *EDM News* online. Published April 2, 2014. <http://www.magneticmag.com/2014/04/two-possible-deaths-at-ultra-music-festival-this-year-2013-death-attributed-to-bath-salts-overdose/>. Accessed September 10, 2014.
 27. Anonymous. Six dead from "meth" at Future Music Festival Asia, 2014. *The Sydney Morning Herald* online. Published March 17, 2014. <http://www.smh.com.au/entertainment/music/six-dead-from-meth-at-future-music-festival-asia-2014-police-20140317-34wev.html>. Accessed September 9, 2014.
 28. Camber R. School boy Daniel Spargo-Mabbs, 16, dies after taking ecstasy at a rave. *Daily Mail Online*. Published January 21, 2014. <http://www.dailymail.co.uk/news/article-2543272/Schoolboy-Daniel-Spargo-Mabbs-16-dies-taking-ecstasy-rave.html>. Accessed September 1, 2014.
 29. Thomson I. Money, music, molly. *The Music Business Journal* online. Published October 2013. <http://www.thembj.org/2013/10/money-music-molly/>. Accessed February 24, 2014.
 30. Zattell J. Final day of New York electronic dance festival cancelled due to drug overdoses. *CTV News* online. Published September 1, 2013. <http://www.ctvnews.ca/entertainment/final-day-of-n-y-electronic-music-festival-cancelled-due-to-drug-overdoses-1.1435885>. Accessed February 24, 2014.
 31. Sherburne P. Tainted ecstasy suspected. *Spin News* online. Published September 16, 2013. <http://www.spin.com/articles/defqon1-death-sydney-suspected-overdose/>. Accessed September 15, 2014.
 32. Anonymous. One dead after drug overdoses at Washington concert. *CBC News* online. Published July 1, 2013. <http://www.cbc.ca/news/world/1-dead-after-drug-overdoses-at-wash-concert-venue-1.1412755>. Accessed February 24, 2014.
 33. Russell K. Police investigating whether a death is connected to drugs. *WXYZ News Detroit* online. Published December 23, 2013. <http://www.wxyz.com/news/police-investigating-whether-a-death-is-connected-to-a-rave-in-novi>. Accessed September 9, 2014.
 34. Martin N. 21-year-old dies after one drop of new synthetic drug. *The Times Picayune* online. Published November 1, 2012. <http://www.nola.com/crime/index.ssf/2012/11/21-year-old-dies-after-one-dro.html>. Accessed September 15, 2014.
 35. Jordan B. 2012: raver dies at BC music festival. *CBC News* online. Published August 13, 2012. <http://www.cbc.ca/news/canada/british-columbia/raver-dies-at-bc-music-festival-1.1273834>. Accessed February 24, 2014.
 36. Grow K. Two deaths reported at the UK's V Festival. *Spin News* online. Published August 20, 2012. <http://www.spin.com/articles/two-deaths-reported-at-the-uks-v-festival/>. Accessed September 15, 2014.
 37. Anonymous. 2 dead among numerous drug, alcohol overdoses at Comcast Center Rave Concert. *Sun Chronicle News* online. Published July 27, 2012. http://www.thesunchronicle.com/news/local_news/dead-among-numerous-drug-alcohol-overdoses-at-comcast-center-rave/article_00aee02c-d500-543a-b5c0-c626ba4f423b.html. Accessed September 2, 2014.
 38. Rong-Gong L II, Pringle P, Blankstein A. Deadly mix of drugs and rave. *LA Times* online. Published February 23, 2013. <http://graphics.latimes.com/towergraphic-coliseum-rave-deaths/>. Accessed September 15, 2014.
 39. Reilly J. Teenager, 19, dies and two of his friends are hospitalized after taking £10 'legal high' Benzo Fury at music festival. *Daily Mail Online*. Published June 11, 2012. <http://www.dailymail.co.uk/news/article-2157524/RockNess-2012-Alex-Heriot-dies-festival-taking-10-legal-high-Benzo-Fury.html>. Accessed September 15, 2014.
 40. Anonymous. Medical examiner: drugs at Kapolei rave led to woman's death. *Star Advertiser* online. Published April 12, 2012. <http://www.staradvertiser.com/news/breaking/147271455.html?id=147271455>. Accessed September 15, 2014.
 41. Cheston P. Clubber who died during 2-day rave killed by overdose. *London Evening Standard* online. Published July 18, 2012. <http://www.standard.co.uk/news/london/clubber-who-died-during-twoday-rave-at-alexandra-palace-killed-by-overdose-not-rogue-ecstasy-7956584.html>. Accessed September 15, 2014.
 42. Ratliff B, Sisario B. Woman found dead at Bonnaroo. *New York Times* online. Published June 10, 2011. http://artsbeat.blogs.nytimes.com/2011/06/10/bonnaroo-organizers-confirm-festival-attendees-death/?_r=0. Accessed September 15, 2014.
 43. Anonymous. Dayglow incident sheds light on growing EMS problems of dance parties. *JEMS Journal* online. Published December 23, 2011. <http://m.jems.com/article/major-incidents/dayglow-incident-sheds-light-growing-ems>. Accessed September 1, 2014.
 44. Mascola L. Ecstasy overdoses at a New Year's Eve Rave. *CDC Reports, MMWR Report*. 2010;59(22):677-681.
 45. Zanotti M. Big day out death inquest commences. *Music Feed* online. Published January 21, 2013. <http://musicfeeds.com.au/news/big-day-out-death-inquest-commences/>. Accessed September 15, 2014.
 46. Anonymous. Fun loving girl died of drug overdose at festival. *Metro News* online. Published January 29, 2009. <http://metro.co.uk/2009/01/29/fun-loving-girl-died-of-drugs-overdose-at-festival-405945/>. Accessed September 15, 2014.
 47. Stein J. Death at Bonnaroo Music Festival. *LA Times* online. Published June 14, 2011. <http://articles.latimes.com/2011/jun/14/news/la-heb-festival-20110614>. Accessed September 15, 2014.
 48. Boles B. What's behind the music fest deaths? *NOW Toronto Magazine* online. Published August 21, 2014. <http://www.nowtoronto.com/news/story.cfm?content=199323>. Accessed September 15, 2014.
 49. Dutch JM, Austin KB. Hospital in the field: prehospital management of GHB intoxication by medical assistance teams. *Prehosp Disaster Med*. 2012;25(5):463-467.
 50. Molloy MS, Brady F, Maleady K. Impact of a single large mass gathering music event, from a series of such events, on a receiving hospital's emergency department (ED). *Prehosp Disaster Med*. 2013;28(1):S186.
 51. Scott M. Rave parties: the problem of rave parties. Center for Problem Oriented Policing. Guide No. 14 (2002). http://www.popcenter.org/problems/rave_parties/. Accessed September 1, 2014.
 52. Bond K, Ospina MB, Blitz S, et al. Frequency, determinants, and impact of overcrowding in emergency departments in Canada: a national survey. *Healthcare Q*. 2007;10(4):32-40.
 53. Bullard MJ, Villa-Roel C, Bond K, Vester M, Holroyd BR, Rowe BH. Tracking emergency department overcrowding in a tertiary care academic institution. *Healthcare Q*. 2009;12(3):99-106.
 54. Schull MJ, Slaughter PM, Redelmeier DA. Urban emergency department overcrowding: defining the problem and eliminating misconceptions. *CJEM*. 2002;4(2):76-83.
 55. Derlet RW, Richards JR, Kravitz RL. Frequent overcrowding in US emergency departments. *Acad Emerg Med*. 2001;8(2):151-155.
 56. Lund A, Turris SA, Bowles R. Mass gatherings and impact on health services in local communities: an operational analysis. *Prehosp Disaster Med*. 2014;29(5):1-7.
 57. MGM Online Registry Project: Mass Gathering Medicine Interest Group. www.ubcmgm.ca/registry. Accessed September 1, 2014.
 58. Essential Rave Dance Moves. *IHeartRaves.com*. Published September 3, 2013. <http://www.youtube.com/watch?v=U9oDZKH9TM>. Accessed March 23, 2014.
 59. Krul J, Sanou B, Swart EL, Girbes ARJ. Medical care at mass gatherings: Emergency Medical Services at large-scale rave events. *Prehosp Disaster Med*. 2012;27(1):71-74.
 60. Hutton A, Cusack L. The perspectives of young people on their use of alcohol and risks at school leavers festivals. *Neonatal, Pediatric Child Health Nurs*. 2013;16(3):16-20.
 61. Merlo L, Ahmedani B, Barondness D, Bohnert K, Gold M. Alcohol consumption associated with collegiate American football pre-game festivities. *Drug Alcohol Depend*. 2011;116(1-3):242-245.
 62. Hutton A, Ranse J, Verdonk N, Ullah S, Arbon P. Understanding the characteristics of patient presentations of young people at outdoor music festivals. *Prehosp Disaster Med*. 2014;29(2):160-166.
 63. Dance Safe Web site. Promoting health and safety within the electronic music community. <http://www.dancesafe.org/>. Accessed March 23, 2014.
 64. Party Safe Program. Queensland Police Web site. <http://www.police.qld.gov.au/programs/cscp/personalSafety/youth/partySafe/>. Accessed March 23, 2014.
 65. The Safe Party Initiative. UC Davis Web site. <http://safeparty.ucdavis.edu/>. Accessed March 23, 2014.
 66. Posadzki A. Taking a trip to a different kind of music festival. *The Globe and Mail* online. Published August 15, 2014. <http://www.theglobeandmail.com/news/british-columbia/taking-a-trip-to-a-different-kind-of-music-festival/article20081824/>. Accessed September 15, 2014.