SPECIAL REPORT

A Prospective Analysis of Patients Presenting for Medical Attention at a Large Electronic Dance Music Festival

Matt S. Friedman, MD;[1] Alex Plocki, DO;[1] Antonios Likourezos, MA, MPH;[1] Illya Pushkar;[1] Andrew N. Bazos, MD;[2] Christian Fromm, MD;[1] Benjamin W. Friedman, MD, MA[3]

1. Department of Emergency Medicine, Maimonides Medical Center, Brooklyn, New York USA
2. Department of Orthopedic Surgery, New York University Langone Medical Center, New York, New York USA
3. Department of Emergency Medicine, Montefiore Medical Center, Bronx, New York USA

Correspondence:
Matt S. Friedman, MD
Department of Emergency Medicine
Maimonides Medical Center
4802 Tenth Ave
Brooklyn, New York 11219 USA
E-mail: mattsfriedman@yahoo.com

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Abbreviations:
DOHMH: Department of Health and Mental Hygiene
ED: emergency department
EDMF: electronic dance music festival
EMS: Emergency Medical Services
IAP: incident action plan
MDMA: 3,4-methylenedioxymethamphetamine
NYC: New York City
PMA: para-methoxyamphetamine
PPR: patient presentation rate
TTHR: transport to hospital rate

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Abstract

Mass-Gathering Medicine studies have identified variables that predict greater patient presentation rates (PPRs) and transport to hospital rates (TTHRs). This is a descriptive report of patients who presented for medical attention at an annual electronic dance music festival (EDMF). At this large, single EDMF in New York City (NYC; New York, USA), the frequency of patient presentation, the range of presentations, and interventions performed were identified.This descriptive report examined consecutive patients who presented to the medical tent of a summertime EDMF held at an outdoor venue with an active, mobile, bounded crowd. Alcohol was available for sale. Entry was restricted to persons 18 years and older. The festival occurred on three consecutive days with a total cumulative attendance of 58,000. Medical staffing included two Emergency Medicine physicians, four registered nurses, and 86 Emergency Medical Services (EMS) providers. Data collected included demographics, past medical history, vital signs, physical exam, drug and alcohol use, interventions performed, and transport decisions.Eighty-four patients were enrolled over 2.5 days. Six were transported and zero died. The ages of the subjects ranged from 17 to 61 years. Forty-three (51%) were male. Thirty-eight (45%) initially presented with abnormal vital signs; four (5%) were hyperthermic. Of these latter patients, 34 (90%) reported ingestions with 3,4-methylenedioxymethamphetamine (MDMA) or other drugs. Eleven (65%) patients were diaphoretic or mydriatic. The most common prehospital interventions were intravenous normal saline (8/84; 10%), ondansetron (6/84; 7%), and midazolam (3/84; 4%).Electronic dance music festivals are a growing trend and a new challenge for Mass-Gathering Medicine as new strategies must be employed to decrease TTHR and mortality. Addressing common and expected medical emergencies at mass-gathering events through awareness, preparation, and early, focused medical interventions may decrease PPR, TTHR, and overall mortality.

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Introduction

Mass gatherings generate a higher incidence of injury and illness than is expected from a similarly sized group of the general population, despite the fact that typically they are a collection of "well persons."[1] Mass-Gathering Medicine literature has focused on predicting medical resource use.[1] Medical needs at mass gatherings are determined largely by the following factors: event type and duration, attendance, weather, crowd mood and density, and alcohol and drug use.[2] For instance, higher medical usage rates have been associated with events of longer duration and extreme weather as well as outdoor events where attendees are exposed to environmental factors.[2] Linear modeling predicts that every 10-degree increase in the heat index is associated with three more medical visits per 10,000 attendees.[3] Likewise, mobile crowds generally have incurred more injuries than when attendees are seated. Excessive alcohol and drug use has led to increased violence and toxicological effects of polysubstance abuse.[2] However, absolute patient volumes tend to decrease with increasing attendance, and sporting events typically have fewer patients than

rock concerts and Papal masses.[4] Crowd mood is an important variable; heavy metal bands attract rambunctious crowds whereas sedating music generally features calm crowds. Electronic dance music festivals (EDMFs) are a relatively new category of mass gatherings with few descriptions in the medical literature. Unfortunately, these festivals combine several of the highest risk elements of mass gatherings leading to significant morbidity and mortality: hot weather; active, mobile crowds who are expending significant energy; and frequent use of illicit drugs.

Electronic dance music is a genre of music that is experiencing a rapid growth in popularity and revenue. The dance music industry generates revenues of US$4.5 billion annually.[5] Much of the revenue results from EDMFs, which as mass gatherings, present both toxicologic and environmental challenges to the medical staff. The increasing popularity of the music coincides with a spike in use of a type of recreational drug, known as "synthetic club drugs" or entactogens. At least 68 deaths have been attributed to drug poisonings at music festivals in the last 15 years; however, the true mortality burden is unknown since non-overdose deaths, such as trauma and drownings, were excluded from analysis.[5] The use of amphetamines, and specifically 3,4-methylenedioxymethamphetamine (MDMA) known as "molly" in powder form and "ecstasy" in pill form, is common at EDMFs.[6] Para-methoxyamphetamine (PMA), another sympathomimetic similar to MDMA but with delayed onset of action and longer duration, has been identified as a cause of fatalities.[7] Additionally, methylone, a synthetic cathinone and bath salt component, also is commonly abused as an adulterant also sold under the name "molly."[6,8,9] These synthetic club drugs are used for their euphoric, stimulatory, and hallucinogenic effects; intoxication with these substances can lead to serious adverse effects, including hyperthermia, hyponatremia, seizures, and rhabdomyolysis.[8-11]

In addition to these toxicologic concerns, the environmental challenges at EDMFs can have lethal effects on attendees. Electronic dance music festivals commonly are held outdoors during hot summer months. Attendance can range from the tens to hundreds of thousands over several-day festivals. Extended dancing outdoors in hot weather, large crowds, drug use, and concurrent alcohol use has led to hospitalizations and deaths at EDMFs.[6] An EDMF in 2013 in New York City (NYC; New York, USA) was cancelled on its third day after two attendees died from complications of MDMA and methylone intoxication.[6,8] With millions of attendees nationwide every year, addressing and enhancing the safety of attendees at EDMFs has become a major public health issue.

After conducting a prospective analysis of Dutch rave parties over a five-year period, the study investigators recommended a minimum medical team of six health care providers for every 10,000 attendees.[12] This model may not be appropriate, however, for all mass gatherings since patient presentation rates (PPR), expressed as patients presenting per 1,000 participants, have varied widely and may be 60-fold higher in some similar mass gatherings.[1] The goal of this descriptive report of a single EDMF in the summer of 2014 in NYC was to identify the frequency of patient presentation to medical attention, the range of presentations, and interventions performed.

Report

This descriptive special report examined consecutive patients who presented to the medical tent of a summertime EDMF in NYC. The Maimonides Institutional Review Board (Brooklyn, New York USA) reviewed and approved this research project. The festival occurred August 29th, 2014 through August 31st, 2014. The total cumulative attendance was 58,000 (58% male), as reported by festival promoters. The outdoor venue was a contained, open field bounded by a ten-foot metal fence. The crowd was active and mobile. The festival was held on an island park within NYC. Transport times to multiple Level 1 trauma centers and tertiary care facilities were approximately 10 minutes. While Emergency Medical Services (EMS) from the local municipality were available, if needed, a private company provided all EMS services and was stationed on site for the duration of the festival. Entry was restricted to adults 18 years and older while vendors sold alcoholic beverages to persons aged 21 years and older. There were extensive security parameters set up, including searches of attendees upon entering the venue and canines trained in drug detection. An amnesty bin was positioned immediately outside the security checkpoint. The festival was held outdoors from 1:00 PM to 11:00 PM each day, and camping was not permitted. The daily outdoor heat index, a metric that combines air temperature and relatively humidity in an attempt to determine the human-perceived equivalent temperature, was 23°C-32°C (73°F-90°F; Figure 1). The minimum and maximum temperatures for the three-day festival were 17°C and 29°C (63°F-85°F). The festival was halted early on the third day when a severe thunderstorm with lightning caused festival promoters to initiate a mass evacuation of the attendees from the open venue.

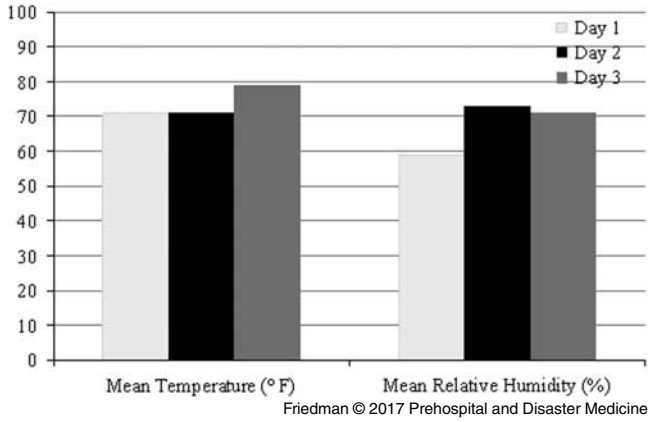

Figure 1. Temperature and Humidity of 2014 EDMF in NYC.

Abbreviations: EDMF, electronic dance music festival; NYC, New York City.

Attendees who presented to the clearly marked medical tent requesting a medical evaluation were enrolled in this descriptive study, regardless of whether they self-presented or were assisted to the medical tent by EMS or friends. Frequently, festival attendees presented to the medical tent requesting oral analgesics, medications for dyspepsia, tampons, bandages, and water. This latter group of attendees was not enrolled, as they did not request medical evaluation. Each patient who was enrolled in the study had vital signs obtained by an emergency medical technician. Medical staffing included two Emergency Medicine physicians, four registered nurses, and 86 EMS providers.

Volunteer research assistants, composed of Emergency Medicine interns, medical students, or college students interested in pursuing a medical career, staffed the medical tent from 1:00 PM

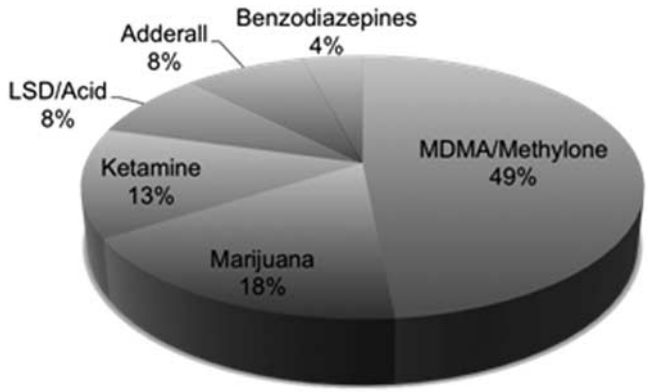

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Figure 2. 2014 Self-Reported Drug Use among Patients with Abnormal Vitals.
Abbreviation: MDMA, 3,4-methylenedioxymethamphetamine.

until 11:00 PM each day, the designated festival hours. The research assistants interviewed each enrolled patient and completed a data collection sheet. Patients' ages, genders, and their duration of time at the festival (measuring the hours exposed to the environmental elements) were collected. A physician then assessed the mental status, pupils, skin, lungs, and bowel sounds. Patients were asked to approximate the ounces of water and the number of alcoholic drinks they had consumed, the type and quantity of drug ingestions, over the counter or prescribed medications they had taken that day, and other features of their medical history. Interventions performed prehospitally, transportation decisions, and dispositions at hospital were collected and recorded on the data collection sheet by the research volunteers.

Emergency Medicine physicians categorized patients' mental status as either calm with normal level of alertness or as altered mental status and agitated, delirious, or comatose. Abnormal vital signs were defined as: heart rate greater than or equal to 100, or less than or equal to 50; systolic blood pressure greater than or equal to 140, or less than 100; diastolic blood pressure greater than 90; respiratory rate greater than 20; and tympanic temperature greater than or equal to 38°C (100°F). Pupillary size and response to light were recorded.

The PPR was calculated based on the number of patients per 1,000 event attendees presenting to the on-site medical staff. The transport to hospital rate (TTHR) was calculated as the number of patients per 1,000 event attendees transported to a hospital. For each of these rates, the total cumulative number of attendees was used.

Results

There were 58,000 attendees at the 2014 EDMF. Eighty-four patients presented to the medical tent and were prospectively enrolled. The mean age of subjects was 23 years (SD = 5.8 years) and 43 (51%) were male. Ten percent of attendees were between 18 and 20 years, 41% between 21 and 24 years, 43% were between 25 and 34 years, and the remainder were 35 years and older. Fifty (60%) patients self-reported drug or alcohol use (Figure 2). Eleven (13%) patients were diaphoretic or mydriatic. Fifty-three (63%) initially presented with abnormal vital signs, including four (5%) who were hyperthermic, 37 (44%) who were tachycardic, and 17 (20%) who exhibited an altered mental state (Table 1). Of the 53 patients with abnormal vital signs, 34 (64%) reported ingestions of presumed MDMA or other illicit drugs. The PPR was 1.45 per 1,000 attendees. Six patients required transport to a hospital. One transported patient required tracheal intubation. The TTHR was 0.10 per 1,000 attendees. There were no deaths at the festival (Table 2).

% Male:	51.8%
Median Age:	22 (range: 17 to 61)
Median Systolic BP:	130 (range: 76 to 180)
Median Diastolic BP:	73 (range: 20 to 120)
Median Pulse:	96 (range 54 to 166)
Median Respiratory Rate:	18 (range: 12 to 26)
Median Body Temperature:	97.9 (range: 96 to 101)

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Table 1. Demographics and Vital Signs of Patients at 2014 EDMF in NYC
Abbreviations: BP, blood pressure; EDMF, electronic dance music festival; NYC, New York City.

	2014
Attendance	58,000
Patients	84
Treat and Release	78
Transports	6
ED Visits	10
ICU Admissions	1
Deaths	0
	34 of 53 (64%) self-reported illicit drug use: most common (47%) synthetic club drug (ie, MDMA, methylone).

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Table 2. Medical Resource Utilization at 2014 EDMF
Abbreviations: ED, emergency department; EDMF, electronic dance music festival; ICU, intensive care unit; MDMA, 3,4-methylenedioxymethamphetamine.

The most common on-scene interventions were administration of intravenous normal saline to eight patients (10%), ondansetron to six patients (7%), midazolam to three patients (4%), albuterol to two patients (2%), and ibuprofen to two patients (2%). Rapid sequence intubation was performed in one (1%) patient. Sixty-seven patients required no intervention.

Discussion

Mass gatherings have the potential to strain the local EMS and health care systems. A mixture of high crowd density, restricted points of access, poor fire safety measures, limited crowd control, and lack of on-site medical care can contribute to increased morbidity among attendees.[13] In the past, some mass-gathering

events required as few as one first-aid provider per 1,000 attendees and one ambulance if the crowd exceeded 5,000.[14] Provision of on-site, physician-level medical care at mass gatherings associated with high PPRs has been shown to significantly reduce the number of patients requiring transport to hospital and therefore reducing the impact on local EMS services.[15] Local emergency departments (EDs) also benefit from on-scene physicians as hospitals are less likely to be overwhelmed by higher than expected patient volume. At one festival in Gorge, Washington (USA), an additional 100 concert-goers per day flooded the local ED.[16]

However, the rural context of these events may be relevant because the geographically closest EDs may not have had the same experience and capacity as urban, tertiary centers in NYC. Another EDMF in Ireland resulted in 39 ED visits in a 24-hour period, requiring nine admissions, two re-admissions, and 25 interventions, including intravenous fluids, suturing, joint reductions, and casting.[17] This EDMF resulted in eight stabbings and two deaths.

Greater insight into the specific nature of EDMFs has led to greater understanding of the unique set of resources required to prepare adequately for such an event. It has been suggested that large, outdoor music festivals should be required to have comprehensive medical care on site, though no high-quality data exist to show its benefit.[18] The strategies employed for this 2014 EDMF included pre-event medical and festival staff education, preparation, development of incident action plans (IAPs), and drilling of those plans. Much of the medical care provided at large outdoor music festivals is beyond the scope of EMS personnel.[18] By anticipating the expected environmental and toxicologic influences on attendees based on data from the same EDMF in 2013, the medical staff achieved a reduction in the PPR from 12.05 to 1.45 and TTHR from 0.23 to 0.10 at the 2014 EDMF[8] (Figures 3 and 4).

At other electronic music festivals, PPRs have varied from eight to 20 per 1,000.[5,12,19] There is clearly a need for easily identified, proactive medical care that is focused on early intervention. These interventions have been shown to reduce use of local health care resources elsewhere as well. A two-day EDMF with approximately 20,000 attendees used a "higher level of care," defined as a multi-disciplinary team including emergency physicians on-site, and reported a PPR of 4.09 and TTHR of 0.52 with a 72.5% decrease in TTHR compared to the previous year. The researchers were able to avoid 29 ED transports.[5]

While stratifying mass-gathering events based on several predictive factors can effectively estimate the number of patient presentations,[20] the authors believe that EDMFs are a high-risk subset of mass gatherings. The NYC Department of Health and Mental Hygiene (DOHMH) developed recommendations to mitigate risk of adverse events at future EDMFs: restricting admission to persons older than 18; employing strategies to reduce excess alcohol consumption; prohibiting the sale of mixed energy-alcohol drinks; providing readily accessible, no-cost drinking water; identifying impaired patrons and bringing them to medical attention; developing a plan to prevent heat-related illness for summer events; distributing harm-reduction public service announcements in advance of and during events; and implementing a surveillance system to rapidly identify adverse health events, including reporting ED transports to DOHMH every four hours.[8]

Mass-Gathering Medicine is an expanding niche in Emergency Medicine. Understanding the potentially compounding influence of environmental and toxicologic factors at EDMFs and implementing focused strategies for medical staffing and resource allocation may decrease the PPR, TTHR, and minimize morbidity and mortality. The authors make the following recommendations: develop and drill IAPs in preparation for disaster scenarios and mass-casualty incidents; clearly identify medical staff and EMS personnel; provide free potable drinking water for attendees; designate multiple access points for EMS in the event of transport or mass-casualty incident; and provide medical staff with intravenous fluids, benzodiazepines, advanced airway equipment (including supraglottic and endotracheal devices), and rapid sequence intubation medications (avoiding succinylcholine due to risk of underlying rhabdomyolysis).

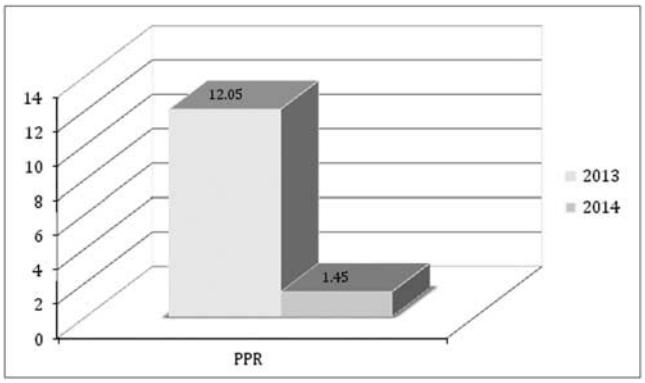

Figure 3. PPR of EDMF in 2013 versus 2014.
Abbreviations: EDMF, electronic dance music festival; PPR, patient presentation rate.

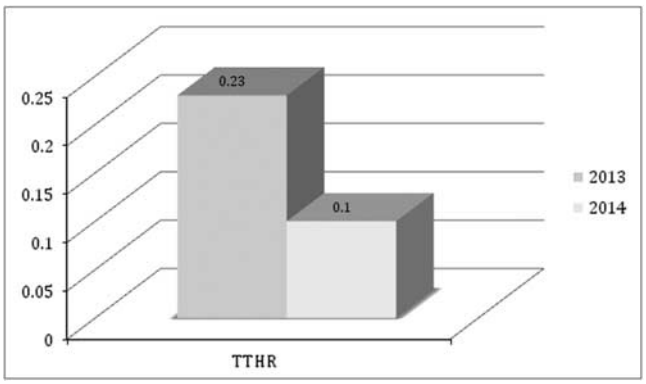

Figure 4. TTHR of EDMF in 2013 versus 2014.
Abbreviations: EDMF, electronic dance music festival; TTHR, transfer to hospital rate.

Areas of future research include investigating which of the interventions and strategies are most effective to decrease PPR and TTHR. Additionally, the authors suggest further study into the generalizability of these strategies to other mass-gathering events.

Limitations

This special report presents descriptive data from a single urban EDMF and may not be generalizable to other EDMFs in different venues in other cities. Each EDMF will vary in terms of prevalence of PMA/MDMA and the purity of illicit substances.

Additionally, the myriad environmental factors differ between each EDMF and may affect the PPR and TTHR substantially.

Decisions regarding transport were made according to the professional judgment of board certified Emergency Medicine physicians. The TTHRs will vary at each EDMF based on the comfort and practice of the individual physician. Since there are no standard guidelines for equipment, minimum staffing, or monitoring capabilities and resources at these events, these factors will vary significantly between each EDMF. Thus, medical facilities with enhanced capabilities and staffing may significantly reduce TTHR.

Conclusions

In this descriptive report of medical events at a large EDMF, the PPR was 1.45 and the TTHR was 0.10. One patient required a critical intervention. Drug and alcohol use was common among patients presenting to medical attention. Further research is needed to determine which interventions can impact PPRs and TTHRs.

Author Contributions

MSF, AP, ANB identified the question of interest. MSF, AP, AL, ANB designed the trial. MSF, AP, AL, IP, CF supervised the conduct of the trial and data collection. MSF, AL, IP, ANB, CF, BWF provided statistical advice on study design. MSF, AP, BWF reviewed and analyzed abstracted data. MSF, AP, BWF interpreted and contextualized the results. MSF, AP drafted the manuscript; MSF, AL, BWF, contributed substantially to editing and revision of the manuscript. MSF takes responsibility for the paper as a whole.

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