Concert Medicine: Spectrum of Medical Problems Encountered at 405 Major Concerts

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Abstract. **Objectives:** To identify factors predictive of patient load at major commercial concert first-aid stations, and to characterize the spectrum of presenting injuries and illnesses at such events. **Methods:** This study was a retrospective case series of patients presenting to on-site first-aid stations at five major concert venues in southern California over a five-year period. The authors compared the number of patients per ten thousand attendees (PPTT) with four potential predictors (music type, overall attendance, temperature, and indoor vs outdoor location) using univariate techniques and negative binomial regression. The spectrum of chief complaints observed is described. **Results:** There were 1,492 total patients out of 4,638,099 total attendees at 405 separate concerts. The median patient load per concert was 2.1 PPTT, ranging from 0 PPTT at 53 concerts to 71 PPTT at a punk rock festival that turned into a riot. Patient load varied significantly by music category ($p = 0.0001$) but not with overall attendance, temperature, or indoor vs outdoor location. Median PPTT by music category ranged from 1.3 PPTT for rhythm and blues to 12.6 PPTT for gospel/Christian, with negative binomial regression indicating that rock concerts had 2.5 times (95% CI = 2.0 to 3.0) the overall patient load of non-rock concerts. Music type, however, was able to account for only 4% of the variability observed in the regression model. Trauma-related complaints predominated overall, with similar rates at rock and non-rock concerts. Four cardiac arrests occurred at classical concerts. **Conclusion:** Rock concert first-aid stations evaluated 2.5 times the patient load of non-rock concerts overall, although there was substantial concert-to-concert variability. Trauma-related complaints predominate at both rock and non-rock events. These data may assist individuals and organizations planning support for such events. **Key words:** concert medicine; musical concerts; trauma; rock concerts; spectators; mass gatherings; first-aid stations; patient load; prediction. ACADEMIC EMERGENCY MEDICINE 1999; 6:202–207

PHYSICIANS are increasingly called upon to organize medical support for mass gatherings such as commercial concerts. Currently individuals and organizations planning such support have little reliable information to assist them in determining what specific personnel and equipment are necessary to optimally support a specific music event. Mears and Batson[1] have reported patient loads at general mass gatherings as ranging from 1.2 to 60 patients per ten thousand spectators (PPTT). The 50-fold range of this projection substantially limits its usefulness as a planning tool, and furthermore it is uncertain whether these data are applicable to the unique characteristics of a commercial concert.

Previous authors have described medical support at single specific concert events (Table 1), with patient loads ranging from 8 to 1,000 PPTT. The volume, acuity, and spectrum of pathology appear dependent on a number of variables, such as music type, concert location, audience age, concert length, audience size, crowd density, crowd movement, weather, indoor vs outdoor location, availability of drugs and/or alcohol, and the "collective mood."[2–7]

Only two studies have reviewed more than a single concert event.[7,8] Erickson and colleagues noted that 48% of patients treated at five rock concerts admitted using alcohol or illicit drugs during the events. The authors did not attempt to identify factors predictive of patient load. De Lorenzo and colleagues found the correlation between crowd size and patient volume at 25 concert events to be weak ($r = 0.3$). The mean patient loads reported by Erickson et al. and De Lorenzo et al. were 12 PPTT and 10 PPTT, respectively.

To the best of our knowledge, no study has attempted to identify predictors of patient load at concert first-aid stations, and accordingly we reviewed five years of experience at five major concert venues. We wished to identify whether any of four factors (music type, overall attendance, temperature, and indoor vs outdoor location) were predictive of patient load (PPTT) per concert. We also

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wished to describe the range of patient loads and spectrum of chief complaints.

METHODS

Study Design. We performed a retrospective review of all patients at five major concert venues over a period of five years. Because of the retrospective nature of this study, it was considered exempt from review by the institutional review board.

Study Setting and Population. MedEvent Corporation is a privately-owned business that specializes in providing medical support for the motor sport and special event industries. They provide on-site emergency medical technician–1s (EMT-1s) to perform triage and first aid at mass gatherings such as concerts, motorcycle races, auto races, film shoots, conventions, and the Academy Awards. All MedEvent medical records were completed by EMT-1s. Emergency medicine residents and attendings also participated in some of the larger events.

MedEvent provided medical care at all consecutive concerts at five southern California venues during the following calendar years: 1) Blockbuster Pavilion (1993–1995) in Devore, 2) Hollywood Bowl (1991–1995) in Hollywood, 3) Los Angeles Coliseum (1991, 1992) in Los Angeles, 4) Los Angeles Sports Arena (1991–1994) in Los Angeles, and 5) Long Beach Arena (1991, 1993) in Long Beach. The first three of these venues are outdoor bowls, and the last two are indoor arenas.

Study Protocol. The primary author (JTG) abstracted age, gender, and chief complaint from MedEvent records for each patient encounter using a standardized data abstraction form. Although the records had no specific section to document alcohol or drug use, the primary author noted whether records indicated any suspected alcohol or drug use.

Chief complaints were classified by the investigators into one of 26 categories as modified from Mears and Batson.[1] For those patient encounters with more than one complaint, we assigned as the chief complaint our best estimation of the most immediate reason for seeking medical attention. Thus, a patient who was intoxicated, became dizzy, fell, and sustained a laceration to the finger was classified according to the chief complaint of "dermal injury."

For each concert, we recorded the artist and overall attendance. The high temperature for the day at the nearest large city for outdoor venues (Blockbuster Pavilion–San Bernardino, Hollywood Bowl–Burbank, Los Angeles Coliseum–Los Angeles) was obtained from the National Climatic Data Center (Asheville, NC). Demographic data were not available describing overall concert attendees. We used two widely circulated music catalogs to categorize music types.[9,10]

We calculated PPTT for each event using patient logs and attendance data.

Data Analysis. We performed all univariate analyses using statistical software (Stata 5, StataCorp, College Station, TX) and considered p-values <0.05 significant. All tests were two-tailed. Since PPTT per event was not normally distributed, the following nonparametric methods were used: Kruskal-Wallis one-way analysis of variance (ANOVA), Mann-Whitney U test, and Spearman rank-order correlation. When Kruskal-Wallis ANOVA demonstrated significant differences, between-group differences were evaluated using the Dunn procedure for nonparametric multiple comparisons.[11]

TABLE 1. Previous Reports of Medical Care at Single-concert Events

Event	Duration	Estimated Attendance	No. Patients	Patients per 10,000 Attendees
Woodstock, New York, 1969*[14]†	19 hours	400,000	5,000	125
Stoke-on-Trent, 1970[15]	24 hours	40,000	493	125
Glastonbury, 1971[16]	5 days	15,000	1,167	80
A "S.E. England" Festival, 1971[17]	2.5 days	150,000	1,712	115
Rolling Stones, 1972[18]	8 hours	47,500	228	50
Music Festival–Auckland, 1973[19]	3 days	20,000	1,998	1,000
Holland, Vermont, 1973[2]	48 hours	35,000	241	8
Watkins Glen, New York, 1973*[20]	4 days	600,000	8,000	133
Diamond Head Crater Festival, 1974[21]	<1 day	40,000	136	34
Sunshine '75[5]	12 hours	35,000	134	40
Heat Wave–Toronto, 1980[22]	36 hours	30,000	512	170
US Festival, 1982[23]	3 days	410,000	2,545	60
Rock Concert–Australia, 1992[24]	1 day	93,000	450	50

*The number of patients for this concert was estimated.
†For complete reference citations, see the reference list.

TABLE 2. Music Category Assigned to a Specific Concert/Artist*

Classical (n = 206)—General or multiple artists (70), America the Beautiful (5), American concert, Bach, Kathleen Battle, Beethoven (12), Boston Pops (2), Brahms (5), Brass Spectacular (2), Bruckner, Budapest orchestra (4), Disney symphony (3), Dvorak Masterpieces, Franck, French Favorites, From Russia with Love, Gershwin (4), Evelyn Glennie, Hollywood Bowl orchestra (5), Israel Philharmonic (2), Italian Festival (2), LA Philharmonic (5), Liszt, Little Russian, Long Beach Symphony, Mahler and Bernstein, Mehta Migdal and Quivar, Mendelssohn (2), Mexico City Philharmonic (2), Mid Summer Night Bowl, Mozart (15), New World, Night in Russia (2), Opera music, Oregon Symphony, Christopher Parkening, Prokofiev, Rachmaninoff (2), Rampal (3), Ravel, Rodgers and Hammerstein (5), Rossini, Salonen (7), Schubert (2), Tchaikovsky (14), Van Cliburn, Wagner and Grieg, Wagner (2), John Williams (4), and Yo-Yo Ma (2)

Country (n = 13)—General or multiple artists (1), Clint Black, Garth Brooks, Billy Ray Cyrus, Alan Jackson, Wynonna Judd, Barbara Mandrell, Reba McEntire, Travis Tritt (3), Hank Williams Jr., and Dwight Yoakam

Jazz (n = 42)—General or multiple artists (3), Adderley and Blakely, Harry Connick Jr., Ella Fitzgerald (2), Dizzy Gillespie, Jobim, Bobby McFerrin (4), Brubeck McRae, Doc Severinsen, and Mel Torme/Peggy Lee

Blues (n = 5)—General (4), and John Lee Hooker

Rhythm and blues (n = 12)—Ray Charles, Natalie Cole (6), Janet Jackson, Whitney Houston, and Luther Vandross (4)

Light sounds/easy listening (n = 21)—General or multiple artists (5), Tony Bennett, Rosemary Clooney (2), Julio Iglesias, Barry Manilow, David Allen Miller, Frank Sinatra, Henry Mancini (2), Mandy Patinkin (2), Pink Panther (2), Dionne Warwick (2), and Andrew Lloyd Webber

Rock/classic rock (n = 71)—Aerosmith, Bad Company/Ted Nugent, Beach Boys, Pat Benatar/Fleetwood Mac/REO Speedwagon, Berlin, Michael Bolton (2), Jimmy Buffett (3), Bob Dylan/Santana (2), Chicago, Damn Yankees, Def Leppard, Amy Grant, Don Henley, Doobie Brothers/Steve Miller, Eagles, Billy Joel, Elton John (2), Four Seasons (2), Jerry Garcia, Grateful Dead (7), Paul McCartney, Moody Blues (2), Oldies (3), Tom Petty (3), Poison, Bonnie Raitt (2), Linda Ronstadt (3), Santana, Paul Simon, Lynyrd Skynyrd, Rod Stewart (4), Spin Doctors, Bruce Springsteen (3), Steely Dan (2), Sting (2), Tina Turner (2), U2 (2), Van Halen, Yes, and Neil Young (3)

Alternative rock (n = 17)—Depeche Mode, Morrissey (2), New Order, Punk Festival, Red Hot Chili Peppers, and REM

Heavy metal (n = 7)—AC/DC, Guns N' Roses, Metallica, Queensryche (3), and Slayer

Gospel/Christian (n = 3)—Gospel Concert

Latin (n = 10)—Antonio Aguilar, Latin Concert, Mariachi (7), and Salsa

Rap (n = 1)—Salt-N-Pepa

World (n = 7)—Gipsy Kings, Bob Marley (3), Reggae, Schamrockin with the Chieftains (2)

*Numbers in parentheses refer to the number of concerts; where no number is listed, a single concert is assumed.

For multivariate analyses, we entered variables with univariate associations of $p < 0.10$ into a Poisson regression equation. Since the assumption of mutual independence of the patient visits could not be ensured (i.e., a single altercation could result in multiple patient evaluations), we also performed negative binomial regression. The likelihood ratio χ^2 was then used to determine which model was most appropriate for the data.

RESULTS

One thousand four hundred ninety-two patients were evaluated at 405 concerts at five venues over five years. All concerts were single-day events ranging in length from four to eight hours. Total attendance at these concerts was 4,638,099. The median concert attendance was 10,999 (interquartile range 7,412 to 14,706), the median number of patients evaluated per concert was 2 (IQR 1 to 4), and the median PPTT per concert was 2.1 (IQR 1.2 to 4.0). Median patient age was 29 years (range 1 to 85 years) in the 591 (40%) patients who had this item recorded. Fifty-seven percent of the patients were female. Music categories and specific artists are shown in Table 2.

Fifty-three concerts had no patients at all. The highest numbers of patients (n = 79) and transports (n = 8) at any event were at a Metallica concert in which a vast array of "mosh-pit"-related trauma occurred. (A "mosh-pit" occurs when a mass of densely-packed people push, slam, and smash into each other while moving about in a circle.) Chief complaints at this event included head injuries (n = 16), lacerations and abrasions (n = 21), extremity injuries (n = 16), a dislocated shoulder, and an abdominal stab wound necessitating eventual surgical repair. In addition, ten patients were evaluated for altered level of consciousness

believed by the primary author, who attended this concert, to be most likely due to the influence of alcohol and/or drugs.

The single concert with the greatest PPTT was at the "Punk Festival," which turned into a riot. Forty-one patients were seen from 5,768 attendees (71 PPTT). Of note, 76% of their chief complaints were trauma-related and 49% of the patients had head injuries. Interestingly, an additional patient at this event (not included in the study) was a police canine brought in to help control the unruly crowd. The dog was transported by helicopter to an animal hospital due to severe dehydration and respiratory distress and died later that day.

Our sample included two stabbings (both at rock concerts) and no gunshot wounds. During most rock concerts at these venues attendees are "patted down" prior to entry by security agents to hinder entry of firearms.

Eleven percent of all patient records (169/1,492) had documentation of alcohol or drug use contributing to the reason for seeking care.

Our sample included four cardiac arrests, and all were at classical concerts. This observed incidence of cardiac arrest was 0.9 per million attendees overall (95% CI = 0.2 to 2.2) and 1.9 per million classical concert attendees (95% CI = 1.0 to 4.9).

Univariate analyses showed that the PPTTs for the six major music categories were significantly different (Kruskal-Wallis, p = 0.0001, Table 3, Fig. 1). Post-hoc between-group analysis showed significant differences with three categories for "rock" (classical, jazz and blues, light/easy listening) and for two categories for "other" (classical, light/easy listening). PPTT was not associated with overall attendance (Spearman rho = 0.046, p = −0.0358), temperature (Spearman rho = −0.058, p = 0.247), or indoor vs outdoor location (Mann-Whitney U, p = 0.325).

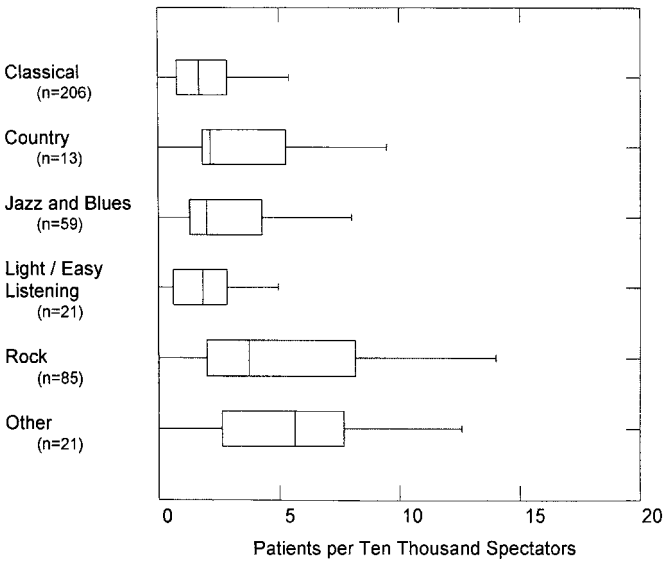

Figure 1. Numbers of patients compared by type of concert. In the boxplots shown, the center vertical line is the median of each sample, with the box edges marking the interquartile range. The lines on either side represent the range of values that fall within 95% confidence intervals.

TABLE 3. Patients Evaluated by Music Category

Music Category	Total Concerts	Total Attendees	Total Patients	Median Age (Yr)	Median Patients per Concert (Range)	Median Patients per 10,000 Attendees (Range)	Median Patient Transports per Concert (Range)
Classical	206	2,096,471	402	48	2 (0–8)	1.7 (0–9)	0 (0–3)
Country	13	125,620	35	29	3 (0–6)	2.2 (0–9)	0 (0–2)
Jazz and blues	59	675,313	224	46	2 (0–22)	2.0 (0–14)	0 (0–2)
Jazz	42	502,863	184	46	3 (0–22)	2.4 (0–14)	0 (0–2)
Blues	5	51,012	20	38	4 (1–9)	2.6 (2–8)	0 (0–0)
Rhythm & blues	12	136,773	21	45	1.5 (0–6)	1.3 (0–5)	0 (0–1)
Light/easy listening	21	215,778	40	40	2 (0–6)	1.8 (0–5)	0 (0–1)
Rock	85	1,258,355	653	25	5 (0–79)	3.8 (0–71)	0 (0–8)
Rock/classic rock	71	982,150	457	27	5 (0–36)	3.8 (0–18)	0 (0–5)
Alternative rock	7	87,579	73	23	6 (2–41)	4.4 (2–71)	0 (0–3)
Heavy metal	7	188,626	123	21	9 (1–79)	3.0 (1–25)	1 (0–8)
Other	21	251,227	137	18	6.5 (0–23)	5.8 (0–17)	0 (0–4)
Gospel/Christian	3	40,500	48	15	17 (8–23)	12.6 (6–17)	1 (0–1)
Latin	10	121,718	57	33	6 (1–11)	5.5 (1–10)	0.5 (0–4)
Rap	1	2,101	2	22	2 (2–2)	9.5 (10)	0 (0–0)
World	7	86,908	30	18	5 (0–10)	3.7 (0–7)	0 (0–1)
OVERALL	405	4,638,099	1,492	29	2 (0–79)	2.1 (0–71)	0 (0–8)

TABLE 4. Chief Complaints by Music Type

	All Music Types (n = 1,492)	Rock Concerts (n = 653)	Non-rock Concerts (n = 839)
Trauma	885	375 (57.4%)	510 (60.8%)
Dermal injury	293	103	190
Eye injury	23	16	7
Foreign body	20	7	13
Head injury	164	115	49
Insect bite	52	3	49
Musculoskeletal injury	308	111	197
Other trauma	23	18	5
Stabbing	2	2	0
Medical	607	278 (42.6%)	329 (39.2%)
Abdominal pain	38	16	22
Alcohol/drug-related incident	127	93	34
Cardiac arrest	4	0	4
Chest pain	25	7	18
Dehydration	2	1	1
Diabetes	5	3	2
Dizziness	62	23	39
Epistaxis	14	8	6
Gastrointestinal complaint	54	9	45
Headache	22	10	12
Heat/cold-related incident	26	9	17
Hyper/hypotension	0	0	0
Obstetric/gynecologic complaint	13	4	9
Other medical complaint	49	23	26
Respiratory distress	54	23	31
Seizure	10	5	5
Syncope	64	14	50
Altered level of consciousness	38	30	8

Since music category was the only univariate predictor of PPTT, we entered this single variable into Poisson and negative binomial regression equations. Since the difference noted in music types appeared almost entirely due to the rock category, we dichotomized this variable as rock vs non-rock. Negative binomial regression was found to be more appropriate for the data (likelihood ratio χ^2, $p < 0.00005$), with a coefficient of 0.897 and an incidence rate ratio of 2.5 (point estimate 95% CI = 2.0 to 3.0). Thus, attendees at rock concerts have, in general, 2.5 times the likelihood of being evaluated at first-aid stations than attendees at non-rock events. However, the pseudo-R^2 for this regression model was only 0.039, indicating that music category can explain only approximately 4% of the total variation observed.

The 95th percentiles for observed patient load at rock concerts and non-rock concerts were 13.7 and 7.1 PPTT, respectively. The spectrum of chief complaints evaluated is shown in Table 4. The proportions of trauma-related chief complaints were similar between the rock and non-rock categories (57.4% vs 60.8%, difference = 3.4%, 95% CI = −8.4% to 1.7%).

DISCUSSION

To the best of our knowledge, this study is the largest analysis of concert medicine reported, and our data suggest that music type may be the best available predictor of patient load at such events. We did not find temperature, overall attendance, or indoor vs outdoor location to be associated with PPTT. Organizers wishing to plan staffing appropriate for the 95th percentiles of observed patient load could use our data (13.7 PPTT for rock, 7.1 PPTT for non-rock) for plannning. It must be acknowledged, however, that the concert-to-concert variability was far higher than the predictive strength of music type, and thus organizers must be prepared for unusual circumstances and perhaps substantially higher patient loads than our data predict.

We found rock music concerts to have higher patient loads than non-rock concerts, with attendees at such events being 2.5 times more likely to be evaluated at first-aid stations than attendees at non-rock events. This may be related to the younger age of these attendees and a higher likely use of alcohol and drugs. Erickson and colleagues noted that 27% of their concert patients admitted to alcohol and/or drug use when questioned.[7] In our study 11% of the patients had documentation of a drug and/or alcohol-related component to their presentations; however, since this item was not routinely assessed, this is likely to be a substantial underestimation of the problem. From the authors' observations, alcohol and illicit drugs frequently contribute to both injury and illness at such events.

Interestingly, the subcategory gospel/Christian music had the highest patient load, with a median of 12.6 PPTT (point estimate 95% CI = 8.8 to 17.3). This subcategory also had the lowest median age (15 years). Since this category included only three concerts, it may not be representative of gospel/Christian concerts in general, and our findings may be due to chance alone.

Women were disproportionately represented in our sample. It is unclear whether this is due to more females attending the concerts or more females becoming ill or injured, or whether females are more likely to present to first-aid stations.

Higher temperatures are associated with in-

creasing risk of heat-related illness, and heat is known to increase aggression.[12] Accordingly, it might be assumed that higher temperatures would increase the number of patients evaluated at mass gatherings. In a previous study of National Football League games in Denver, Colorado, Pons and colleagues noted, "the number of patients evaluated greatly decreased as the temperature during the season dropped."[13] The present study, however, did not demonstrate a relationship between high daily temperature for the day (range 59–107°F) and the PPTT. Weather conditions in southern California are mild and less humid compared with those in Colorado, and thus such a relationship might be observed in other settings. Also, since most concerts were during the evenings, the high temperature for the day may not have been an accurate estimation of the temperature at the actual concert.

The availability of on-site medical care has become the standard at most mass gatherings. The level of care at the particular event should be based on the type of concert, venue, length of concert, particular performers, and local emergency medical services access and resources.

LIMITATIONS AND FUTURE QUESTIONS

This study is subject to the usual limitations of retrospective studies, including dependence on medical record documentation quality. We believe that these factors have minimal impact on our results, because the information we abstracted from records was objective and not prone to misinterpretation or abstractor bias. Although age data were completed on only 40% of the records, chief complaint was uniformly documented.

Since certain categories of concerts (i.e., rap, gospel/Christian, blues) had a small number of events, our findings may not be representative of these types of concerts in general.

This study is also limited in describing the spectrum of patients and severity of patients seen. Ideally, this should be based on the final diagnosis; however, due to the nature of the study and the level of care providers, chief complaint was used instead.

The data were collected in southern California, and it is uncertain how climatic differences in other regions might produce variances in overall patient load and spectrum of illness.

Future studies should assess the demographic factors of concert attendees as a whole to determine how attendee gender, age, and/or socioeconomic status might influence patient load. More accurate data regarding alcohol and drug use would permit better characterization of their contribution to the injuries and illnesses observed.

CONCLUSIONS

We found that rock concert first-aid stations evaluated 2.5 times the patient load of non-rock concerts overall, although there was substantial concert-to-concert variablility. Trauma-related complaints predominate at both rock and non-rock events. These data may assist individuals and organizations planning support for such events.

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