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Subway Train-Related Fatalities in New York City: Accident versus Suicide*

ABSTRACT: We examined the characteristics of subway train-related fatalities in New York City between Jan. 1, 2003 and May 31, 2007 in order to determine which factors are useful in differentiating accident from suicide. Subway train-related deaths with homicide and undetermined manners also are included. During this period, there were 211 subway train-related fatalities. The manners of death were: suicide ($n = 111$), accident ($n = 76$), undetermined ($n = 20$), and homicide ($n = 4$). The causes of death were blunt trauma ($n = 206$) and electrocution ($n = 5$). Torso transection and extremity amputation were more frequent in suicides. Antidepressant medications were more frequently detected in suicides, whereas cocaine and ethanol were more frequent in accidents. However, autopsy findings should be weighed in the context of the entire evaluation along with other circumstantial and investigative findings. In unwitnessed deaths where additional information is unavailable or discrepant, the most appropriate manner of death usually is undetermined.

KEYWORDS: forensic sciences, forensic pathology, accident, suicide, subway, train, fatality

The cause of death in subway train-related fatalities usually is obvious. Determination of the manner of death, however, can be a challenge. A common dilemma is the differentiation between accident and suicide. Eyewitness accounts provided by bystanders or train operators often play an important role in making such decisions. However, eyewitness accounts are neither always available nor reliable. Furthermore, multiple eyewitnesses may provide conflicting accounts. Therefore, the medical examiner/coroner must consider all aspects of a complete investigation including: eyewitness accounts, patterns of injuries, medical and psychiatric history, scene investigation, and toxicology results.

Prior studies have examined train-related injuries and fatalities in the United States (1–5) and abroad (6,7). Most of these studies involve train-pedestrian and train-vehicle collisions on above-ground railway systems. A few studies have examined injuries due to subway train-pedestrian impacts (8). Alcohol, other intoxicants, and operator fatigue have been identified as common contributing factors to train-related accidents (1). There are few autopsy studies, however, with large numbers of well-documented train-related suicides. Examination of subway train-related fatalities in New York City provides a unique opportunity to compare findings of accidental and suicidal train-related deaths since both occur frequently in New York City.

There are many reasons to study train-related fatalities. Train-related fatalities are among the most common transportation-related deaths after motor vehicle collisions. Many accidental train-related fatalities are preventable. Data concerning accidental train-related fatalities may help to improve train, track, and platform safety design, as well as general operational and safety procedures. Injuries documented at autopsy are routinely incorporated into databases maintained by oversight and investigatory authorities such as

the National Transportation Safety Board and used for safety analysis. The manner of death may also be important for the resolution of a life insurance policy or assessment of civil and criminal liability.

For all of these reasons, our study aims to contribute to the literature of train-related fatalities through a description of the physical injuries, circumstances, toxicology findings, and other factors associated with subway train-related fatalities. Given the frequency of subway train-related fatalities, the differentiation between accident and suicide is a common issue faced by medical examiner/coroners. This study identifies characteristics that may help to make that distinction.

Methods

Case Selection

A database search was performed for the words “subway,” “train,” or “tracks” within all fields of medical examiner death certificates issued between Jan. 1, 2003 and May 31, 2007. Only deaths associated with the New York City subway system were included. Any death associated with New York City’s other railways such as the Long Island Railroad (LIRR) and the Port Authority Trans Hudson (PATH) system was excluded. Any death due to a natural cause while riding on the train or waiting on the platform was excluded. Any unnatural death not related to impact with the subway train or electrocution by contact with the third rail was also excluded. For example, death due to a fall down stairs while entering the station would be excluded. Decedents found on the subway tracks with apparent blunt impact or electrocution injuries were included.

In general, deaths due to impact with a subway train undergo autopsy in New York City unless there is a religious objection on behalf of the decedent, in which case an external examination is typically performed. Under New York law, a religious objection to autopsy must be honored unless there is a suspicion of homicide or an imminent threat to public health. The manner of death is determined from the cause and circumstances of death. The manners of death listed on the United States Standard Certificate of Death

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include: natural, accident, suicide, homicide, and undetermined. Suicide is defined as a violent death caused by an act of the decedent with the intent to kill him or herself.

Toxicological analysis was performed on all deaths. Specimens routinely collected include: blood (peripheral preferred), urine, bile, vitreous humor, brain, liver, and gastric contents. Autopsy blood specimens were collected with addition of sodium fluoride and stored at 4°C. Urine specimens were routinely tested for opiates, barbiturates, benzoylecgonine (BE), cannabinoids, amphetamines, phencyclidine, and methadone by enzyme immunoassay. In cases where urine was not available, blood was tested for opiates, benzoylecgonine, barbiturates, and cannabinoids using radioimmunoassay. Urine or blood was also screened for basic drugs (including ketamine and cocaine) by gas chromatography with a nitrogen phosphorous detector. The toxicology laboratory at the Office of Chief Medical Examiner analyzed all specimens.

Data Analysis

All available documents in the medical examiner file including autopsy report, scene investigation report, police report, and toxicology results were reviewed. Only major injuries—fractures, lacerations, and visceral contusions—were counted for each body compartment: head, torso, and extremity. Skin abrasions and contusions were not included if there were no other underlying injuries. Extremity amputations, torso transections, and decapitations were also tabulated. The presence of a history of mental illness was determined by review of medicolegal investigation reports, medical records, and a standardized check-list of medical conditions filled out by family members who identify the body. The presence of a witness account was determined by review of medicolegal investigation reports and police reports. Toxicology results were considered positive if any quantity was detected. Only blood-alcohol concentrations were tabulated for statistical purposes. Basic statistical analysis was performed on a Microsoft Excel spreadsheet.

Results

Two-hundred and eleven subway train-related fatalities were investigated by the Office of Chief Medical Examiner of the City of New York between Jan. 1, 2003 and May 31, 2007. Of these 211 deaths, 175 underwent autopsy and 36 were examined only externally. The manners of death were: suicide (*n* = 111), accident (*n* = 76), undetermined (*n* = 20), and homicide (*n* = 4). The causes of death were blunt trauma (*n* = 206) and electrocution (*n* = 5) (Table 1). Of the five deaths due to electrocution, four were accidents and one was as a homicide. The average age was 44 years with a range of 14–85 years. There was a male to female ratio of *c.* 5 to 1. Distribution by race/ethnicity was 32% Caucasian, 28% African-American, 28% Hispanic, and 11% Asian, which approximates the racial distribution in New York City according to 2000 U.S. Census data (Table 2). The majority of deaths (*n* = 180) were

TABLE 1—Cause and manner of death.

Manner	Number	Percentage (%)
Suicide	111	52
Accident	76	36
Undetermined	20	9
Homicide	4	2
Cause		
Blunt force	206	98
Electrocution	5	2

TABLE 2—Gender and race distribution of study population and general New York City population.

Sex	Number	Percentage	NYC* (2000)
Male	176	83%	47.4%
Female	35	17%	52.6%
Race/ethnicity			
Caucasian	68	32%	35%
Hispanic	61	28%	27%
African-American	59	28%	27%
Asian	23	11%	10%

*2000 U.S. Census.

not associated with a survival interval, and a minority (*n* = 31) occurred after a survival interval ranging from 1 h to 18 years. Witness accounts were available in 66% of the accidental deaths and 95% of the suicidal deaths. A suicide note was found in only 6% of the suicides.

There was no apparent temporal trend in the annual number of deaths during the study period with *c.* 45–50 deaths each year. There was greater month-to-month variability among suicides than accidents. The greatest number of suicides occurred in May (*n* = 15), and the lowest in Sept. (*n* = 2). Accidental deaths showed a bimodal distribution with peaks in March (*n* = 9) and Dec. (*n* = 9), and troughs in Jan. (*n* = 4) and Sept. (*n* = 3) (Fig. 1). By day of the week, accidental deaths showed relatively low day-to-day variability with the greatest number occurring on Thursday (*n* = 13) and the lowest on Monday (*n* = 8). Suicides showed greater day-to-day variability than accidents. The greatest number of accidents occurred on Tuesday (*n* = 26) and the lowest on Wednesday (*n* = 8) (Fig. 2). The distribution of deaths by time of day shows the greatest number of suicides (*n* = 29) occurring in the 08:00–12:00 time period and the greatest number of accidents (*n* = 19) occurring in the 04:00–08:00 time period. The fewest number of accidents and suicides occurred during the 00:00–04:00 time period (Fig. 3). When subdivided by hour, the greatest number of accidents occurred during the 04:00 h, and the greatest number of suicides during the 13:00 h.

Ethanol was detected in 42% of the accidental deaths with an average blood-alcohol concentration of 0.20 gm%, compared with 14% of suicides with an average blood-alcohol concentration of 0.16 gm%. Cocaine and/or benzoylecgonine was detected in 25% of the accidental deaths, compared with 3% of the suicides. Cocaine and/or benzoylecgonine and/or ethanol was detected in 63% of accidental deaths compared with 14% of suicidal deaths. Antidepressant medications were detected in 8% of the accidental deaths compared with 21% of the suicides. Head, torso, and extremity injuries occurred in 84%, 70%, and 62% of accidental

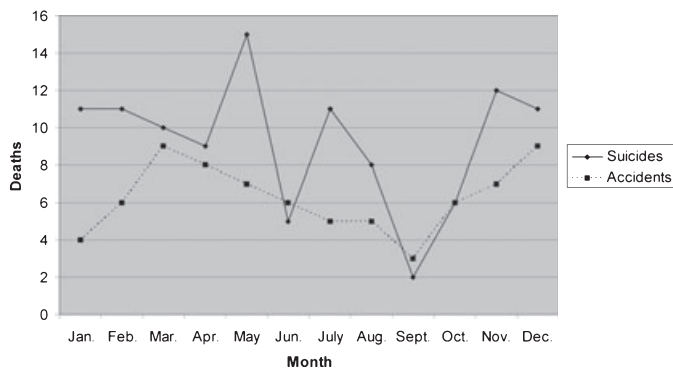


FIG. 1—Deaths by month.

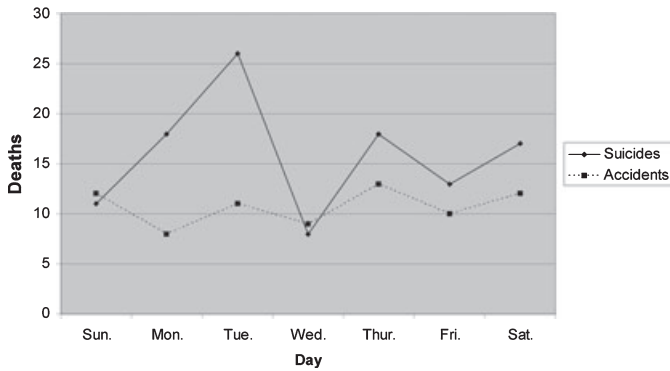


FIG. 2—Deaths by day.

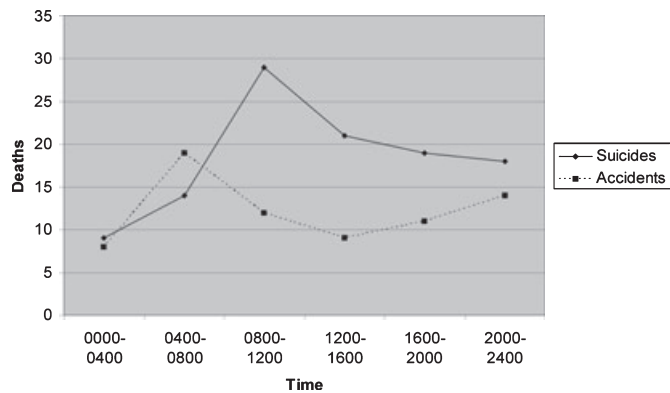


FIG. 3—Deaths by hour.

deaths compared with 90%, 80%, and 77% of suicides, respectively. There were skull fractures in 53% of accidental deaths compared with 65% of suicides. Decapitation and torso transection occurred in 1% and 3% of accidental deaths compared with 7% and 8% of suicides, respectively. There was a history of either depression, schizophrenia or an unspecified psychiatric disorder in 34% of the suicides compared with 3% of the accidents. There was a history of substance abuse in 8% of the suicides compared with 25% of the accidents (Table 3).

There were five deaths of New York City subway employees who were working at the time of injury. Four workers were performing track maintenance and one worker was a train conductor who struck his head on a structural support while sticking his head out of the conductor's window. There were 11 deaths among people known to be homeless. These deaths usually occurred within the subway tunnel, rather than in the station section of the subway tracks. There were six deaths where the decedent was a passenger on the train and subsequently fell off, all of whom were apparently attempting to urinate while riding in between cars, and five of whom were intoxicated. There were three deaths during "train surfing" that involves the passenger riding on the roof of a subway train.

Overall, 166 deaths were witnessed. Of the witnessed deaths, 105 (63%) were certified as suicide, 50 (30%) as accident, and 7 (4%) as undetermined. Witness accounts were provided either by the motorman only (43%), bystanders only (40%), or both (15%) and were supportive of the respective manner of death certification. There were 45 unwitnessed deaths. Of the unwitnessed deaths, 26 (58%) were certified as accidental and 6 (13%) as suicide based largely on circumstantial and other information obtained from the

TABLE 3—Accident versus suicide.

Demographic	Accident (n = 76)	Suicide (n = 111)
Average age (years)	43.9	45.2
Age range (years)	14–84	14–85
Male (%)	86	81
Circumstances (%)		
Witnessed	66	95
Suicide note	0	6
Physical injuries (%)		
Head injury	84	90
Torso injury	70	80
Extremity injury	62	77
Extremity amputation	25	38
Skull fracture	53	65
Decapitation	1	7
Torso transection	3	8
Toxicology (%)		
Ethanol	42	14
Cocaine/BE*	25	3
Cocaine/BE/ethanol	63	14
Antidepressants	8	21
Benzodiazepines	7	8
Methadone	9	4
History (%)		
Depression	0	19
Schizophrenia	1	5
Psychiatric disorder, NOS**	1	12
Dep./Schiz./Psych., NOS	3	34
Substance abuse	25	8

*BE, Benzoylcegonine.

**NOS, not otherwise specified.

TABLE 4—Witnessed versus unwitnessed.

Manner	Witnessed (%)	Unwitnessed (%)
Suicide	63	13
Accident	30	58
Undetermined	7	29

death investigation. Thirteen (29%) of the unwitnessed deaths were certified as undetermined for manner (Table 4).

There were 20 deaths with an undetermined manner, all due to blunt trauma. Of the undetermined deaths, 35% were witnessed. There were four homicides, of which two victims were pushed into the path of a subway train. In one homicide, the victim was chased into a tunnel and subsequently struck by a train. The remaining homicide involved an unwitnessed assault followed by a fall onto the subway tracks and electrocution by contact with the third rail. This last case is later described in greater detail.

Discussion

The New York City subway transit system transports *c.* 1.5 billion passengers per year. It is the fourth most-used subway transit system in the world, behind the Tokyo, Moscow, and Seoul subway systems (9). The peak riding times are during the morning rush hours from 6:30 AM to 9:30 AM and the evening rush hours from 3:30 PM to 8:00 PM. Our study found that the largest number of subway train-related accidents occurred prior to the morning rush hour period, and the largest number of subway train-related suicides occurred during the morning rush hour period (Fig. 1). When examined by one-hour time periods, the greatest number of accidents occurred in the hour after 04:00 which, interestingly, is the latest closing time for bars in New York City. When examined by day of the week, the greatest number of suicides occurred on

Tuesdays. This finding is consistent with prior studies that have found the greatest risk for train-related suicides on Monday or Tuesday, possibly due to psychosocial stress triggered at the beginning of the work-week (7).

There are two common patterns of suicide by subway train. One pattern is for the decedent to wait on the platform for the approaching train and then to jump directly into the moving train. In this pattern, bystanders may provide conflicting eyewitness accounts because they are not cognizant of the decedent's behavior prior to jumping. More often than not, the train operator, who sits in the operator compartment of the first car, will provide the most compelling and detailed eyewitness account. A second pattern is for the decedent to jump off the platform onto the subway tracks just as a train is entering the station, thereby providing a short period of time prior to impact, during which the decedent may lie down on the subway tracks or brace for impact. In this pattern, bystanders and the train operator usually provide corroborating accounts supportive of suicidal intent. The physical injuries tend to be severe and focal, often with amputations of the neck/upper torso, and lower torso/lower extremities. A characteristic, though likely not pathognomonic, autopsy finding is a horizontal linear contusion along the back which patterns the width of a subway rail (Fig. 4).

In our study, there were no suicides by electrocution due to deliberate contact with the electrified third rail even though the third rail is relatively easy to access from the subway tracks and would result in a fatal electrocution because it conveys a voltage of *c.* 600 V direct current (10,11). Although low-voltage electrocution as a means of suicide has been reported previously (12), suicide by high-voltage electrocution is exceptionally rare. Though often cited as an "urban myth," electrocution by urinating on the third rail has also been previously reported (11).

Compared with previous studies of train-related fatalities in other cities, our study has a larger proportion of suicides. In our study, 53% of the deaths were suicides compared with 4% found by Cina et al. (3), 8% by Davis et al. (2), and 8% by Pelletier (1). The higher proportion of suicides in our study can be explained by a number of factors, but the key factor is the limitation of our study to a subway train system, whereas prior studies primarily involved above-ground railway systems. Above-ground railway systems frequently incorporate road crossings, where train-car and train-pedestrian accidents are most likely to occur, whereas no such authorized crossings are present in the New York City subway

system. Subway passengers must cross tracks via a separate platform. Another difference between an above-ground railway system and a subway system is the higher density of passengers, and thereby, witnesses, on a subway system. Therefore, it would be expected that a subway train-related death is more likely to be witnessed than an above-ground train-related death. In the absence of a witness account demonstrating clear intent, medical examiner/coroners may defer toward a determination of accident or undetermined because the operational criteria for suicidal intent (13) cannot be met.

Accidental deaths due to impact with a subway train may receive a great deal of scrutiny by the public and investigating authorities because they often are preventable. As with suicidal deaths, eyewitness accounts usually provide the most useful information. The accidental deaths in our study occur within a diverse set of circumstances. The most common pattern is that of a trespasser who attempts to walk across or along the tracks without any self-injurious intent. Another pattern is that of a passenger who accidentally falls onto the subway tracks just as the train is approaching. Another pattern is that of a passenger who leans over the edge of the platform and looks the wrong way for an oncoming train and is struck on the back of the head. Rarely, a passenger aboard a train will fall off while riding in between cars, usually while intoxicated and attempting to urinate. Our study found that intoxication with ethanol or cocaine was a contributing factor in the majority of accidental deaths.

There were four work-related deaths among New York City subway track maintenance workers. Track maintenance work occurs under difficult and dangerous circumstances, with workers often carrying heavy equipment across electrified rails and alongside passing trains in constrained spaces. There are safety protocols so that track workers are alerted to approaching trains, but sometimes these protocols may be inadequate or not followed (14).

Rare accidents in our study were due to "train surfing" whereby a passenger attempts to ride on top of the train between stations. A related activity called "skylarking" involves riding a train while hanging onto the outside of the doors (15). Death results from impact with overhanging beams or other support structures. In 2003, three "train surfing" deaths occurred within a relatively short period of time; two of them resulted from the same incident. Fortunately, these incidents now occur with less frequency partly due to local media coverage of these deaths (16).

Homicidal subway train-related fatalities are rare. Two of the four homicides in our series resulted when the victim was pushed into the path of a subway train in the course of an assault. One homicide resulted after a victim was chased into the tunnel and subsequently struck by a subway train. One unusual homicide involved a victim who was apparently robbed, assaulted, and then pushed onto the subway tracks early in the morning without any witnesses. He was first seen lying on the subway tracks by a train operator who was able to stop the train prior to impact. The victim was then observed to stumble and fall onto the electrified third rail. The cause of death was electrocution but autopsy also revealed blunt impact injuries of the face which could not be accounted for by the electrocution or a fall off the platform. Police investigation determined that the decedent's wallet and other personal belongings were missing. If the train operator had not been able to stop the train prior to impact, the blunt impact injuries to the face could have been masked by other impact injuries. This case demonstrates the hazards of certifying the manner of death in subway train-related fatalities, especially when the circumstances of the injuries are unwitnessed.



FIG. 4—Characteristic horizontal patterned contusion of subway rail in suicidal subway train-related fatality.

There were 20 deaths with an undetermined manner in our series. Witness accounts were available in 35% of the undetermined deaths. In most of the witnessed undetermined deaths, the decedent was lying or walking along the tracks and the death investigation was unable to determine why the decedent was on the tracks. Witness accounts were not available in 65% of the undetermined deaths. In a large number of the unwitnessed deaths, the decedent's body was found on the subway tracks with apparent blunt impact injuries resulting from impact with a subway train, but there was minimal or no circumstantial information. Ethanol or cocaine was detected in the majority of these undetermined deaths. In those unwitnessed deaths where the decedent's body was found in the tunnel section of the subway, it is possible that the decedent lived in abandoned subway tunnels and was accidentally struck by a train. It is also possible that the person was fleeing a criminal threat (which would make the death a homicide). With the paucity of circumstantial information and the above mentioned hazards of certifying unwitnessed subway train-related fatalities, it is prudent to certify these deaths with an undetermined manner.

Accident versus Suicide

Eyewitness accounts are the most helpful factor for determining the manner of subway train-related deaths. A detailed eyewitness description of a decedent jumping into the path of a train or lying down on the tracks is compelling evidence of suicidal intent in most circumstances. The finding that suicides have a higher rate of eyewitness accounts than accidents may be a reflection of the requirement to demonstrate intent in order to certify a death as a suicide. Without evidence of clear suicidal intent, these deaths typically would be certified as accidents or undetermined manners. A suicide note also provides compelling evidence of suicidal intent, but a suicide note was found in only 6% of the suicides. The low number of suicide notes may be a reflection of the impulsiveness of these deaths. Prior expression of intent and prior suicide attempt are other helpful factors (13). A history of psychiatric illness may help differentiate suicide and accident. In particular, a history of depression and/or a nonspecified psychiatric illness was more commonly identified in suicides than accidents, whereas a history of substance abuse was more commonly identified in accidents. Particular caution must be used with schizophrenic deaths. If there is a likelihood that the decedent was delusional and psychotic, even a witnessed intentional jump may not meet the definition of suicide (i.e., intent to die) and may be better certified as accident or undetermined.

Age and sex are not helpful to distinguish between accidental and suicidal deaths. Most accidental and suicidal deaths occur among middle-aged men. There was a slightly higher incidence of important physical injuries (fractures, lacerations, and visceral contusions) of the head, torso, and extremities among suicidal deaths, but the difference is not helpful for distinguishing between the two manners. Specific injuries such as extremity amputation and skull fracture also do not appear to be helpful. Decapitation and torso transection appear to favor suicide, but not in all cases.

Toxicology may help distinguish between accident and suicide. The greatest discrepancies occurred with detection of cocaine, ethanol, and antidepressants. Cocaine and ethanol were more commonly associated with accidents while antidepressants were more commonly associated with suicides. The blood-alcohol concentration was slightly higher among accidental deaths. There does not appear to be any useful difference in the detection of benzodiazepines or methadone between accidents and suicides.

In summary, this study describes the characteristics of subway train-related fatalities in New York City and provides data which may help distinguish accidental and suicidal deaths. As shown in a previous study (3), certain physical injuries such as decapitation and torso transection are more indicative of suicide. Also shown in a previous study (1), toxicology results, particularly the detection of ethanol and cocaine, tend to be associated with accidental deaths. A history of depression is associated more with suicides and a history of substance abuse is associated more with accidents. There is, however, substantial overlap and no single autopsy, scene, historical, or toxicological finding is pathognomonic for the manner of death. Furthermore, no single finding should be interpreted in isolation and no study should substitute for sound judgement in the certification of death. Certification of the manner of death in subway train-related fatalities should be performed with knowledge of all aspects of a thorough death investigation, including: eyewitness accounts, medical and psychiatric history, scene investigation, autopsy findings, and toxicology results. In unwitnessed deaths where additional information is unavailable or discrepant, an undetermined manner may be appropriate.

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