
Suicidal Behaviour on Subway Systems: A Review of the Epidemiology

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ABSTRACT *Suicide on subway systems is a public health challenge that has been reported in urban centers worldwide. Our objective was to analyze studies of suicide on subway systems, develop a profile of characteristics that are suggestive of association with suicides or attempts, and show how this profile can inform prevention. A literature review involving epidemiology studies and studies relating to subway suicide was conducted. Twenty-eight studies were included in this review. Across studies, characteristics were not often assessed for risk factor status, although several characteristics were remarkably similar. Those attempting suicide on the subway appear to be affected by serious mental illness and have contact with mental health services before the suicidal behavior. Several characteristics may be shared among this population, emphasizing the potential for prevention in clinical and public health domains. Well-designed studies that utilize robust data collection and statistical methods are needed to establish the risk status associated with these characteristics.*

KEYWORDS *Attempted suicide, Prevention, Subways, Suicide.*

INTRODUCTION

There are approximately 135 subway systems that exist in the metropolitan areas of countries worldwide.^{1,2} Since Guggenheim and Weisman's initial study in 1972, suicide on subway systems* has been continually reported as a public health challenge.²⁻⁴

Suicide on railway systems has been increasingly represented in the literature. This includes a special issue of *Social Science & Medicine*⁵ dedicated to the topic, as well as a comprehensive, multidisciplinary study of suicide on the UK railway system (SOVRN, Suicides and Open Verdicts on the Railway Network).⁶ While it is estimated that railway suicide accounts for only 5% of suicides in the UK, the

*Other terms for subway systems include metro, tube and underground systems.

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authors of the latter report reason that the “human costs” to train drivers and bystanders is great, and the opportunity to prevent suicide by targeting this method may lead to a decrease in the overall rate.^{6,7}

Like railway suicide, subway suicide may be preventable and undoubtedly has psychological costs to train drivers and the high number of passengers who use the service. Subways operate at a high speed, capacity, and frequency within urban centers and occupy pathways that are independent from other forms of motorized traffic.⁸ As such, they provide a distinct environment within which suicidal behavior occurs. Studies performed globally have yielded remarkably similar findings from which we can begin to develop a profile of characteristics that are suggestive of an association with suicides or attempts. In the context where attempters may have considerable prior contact with mental health services, the clinical detection of such characteristics may prove to be an effective means of prevention. In this review, we analyze studies on subway suicide, develop a profile of characteristics that are suggestive of association with suicides or attempts and show how this profile may inform prevention.

MATERIALS AND METHODS

A systematic method was used to search articles in the MEDLINE (Pubmed) and PsycINFO electronic databases. The search was limited to English language articles. The following combinations of synonyms referring to subways were used: (subway OR railway OR metro OR underground OR tube) and (suicide OR injury). The use of the ‘railway’ term ensured that subway studies that were grouped under this category were targeted. The references of each retrieved study were checked to recover studies that were missed in the database search.

6,110 abstract matches were found. In accordance with our aims, only articles that pertained to the epidemiology, prevention and psychiatric aspects of suicides or suicide attempts on subway systems were included (alternate names for subway systems referenced by retrieved articles included mass urban transit, metro, metro rail and underground systems). While important to the issue, studies of the forensic details of injuries and psychological effects on subway train operators did not meet these criteria and were excluded. Studies that reported on epidemiological data primarily from railway systems, without data from subway systems, were excluded. Twenty-eight articles met these criteria and were retrieved.

To cohesively review the articles that were retrieved, we defined *suicide* as a self-harming behavior, with intent, that involves the subway and results in death. A *suicide attempt* was defined as a self-harming behavior, with intent, that involves the subway and does not result in death. A *suicide incident* was defined as an inclusive term for both suicides and suicide attempts. It is important to note that these definitions were not used as inclusion criteria during the initial search.

RESULTS

The articles that met the inclusion criteria were retrieved for analysis (see Tables 1 and 2). These studies used data from systems in Boston, Calcutta (Kolkata), Hong Kong, London, Montreal, Munich, New York, Toronto and Vienna. Additionally, one study compiled data from 23 metro systems (Athens, Boston, Budapest, Caracas, Helsinki, Hong Kong, London, Mexico City, Milan, Munich, Nuremberg,

TABLE 1 Studies reviewed: Epidemiology studies (12)

References	City, country	N (suicides/deaths), N (attempts/alive)	Duration of Analysis	Source of Data
Authors, years				
Chowdhury et al. ²¹ , 2000	Calcutta (Kolkata), India	13, 22	1988 (Aug.)–1998 (Dec.)	NR, MSR, AI, CI, FI
Coats and Walter ²² , 1999	London, UK	33 (dead), 25 (alive)(outcome indicated as dead/alive)	1996 (Jan.)–1997 (Mar.)	MSR
Cocks ²⁹ , 1987	London, UK	Not measured, 106 (deliberate self-harm probable in three quarters of total sample; 43 died at the accident scene or shortly after admission to hospital)	1981–1986	TPR, HR, CR, ED
Farmer et al. ²⁷ , 1994	London, UK	3,144 suicide incidents	1940–1989	MSR, TPR, CR, AI
Gaylord and Lester ²⁴ , 1994	Hong Kong SAR	56, 76	1979–1991	MSR, TPR
Guggenheim and Weisman ³⁶ , 1972	Boston, USA	17, 33	1960–1967	MSR, PI, HR, CR, AI, FI
Johnston and Waddell ²⁵ , 1984	Toronto, Canada	207, 223	1969 only (4 attempters)	MSR, CR, PR, HR, OS
Ladwig and Baumert ³ , 2004	Munich, Germany	119, not measured	1980–1999	MSR, NSS
Mishara ²⁶ , 1999	Montreal, Canada	(119 suicides were studied in detail) 202, 104	1986 (Mar.)–1996 (start)	CR
O'Donnell and Farmer ²⁷ , 1994	London, UK	129, 323	1940–1990	MSR, TPR
O'Donnell and Farmer ⁴ , 1992	23 metro systems ("variously known as metros, undergrounds, subways or tubes")	(only the 129 suicides were studied) 3240 suicide incidents	Varying times	MSR
Sonneck et al. ²⁸ , 1994	Vienna, Austria	See paper for findings of each system 56, 33	1980–1992	NR

AI/attempter interviews; CAS case report; CI clinical interviews; CR coroner's records; DR death registers; ED emergency department records; FI family member interviews; FS field study; HR hospital records; KI key informant interviews; MSR metro system records; NR newspaper reports; OS national or city-wide statistics; PI physician interviews; PR psychiatric records; SV suicide notes; TPR police or transit police records; TR trauma registry

TABLE 2 Studies reviewed: Follow-up studies of attempters and miscellaneous studies (16)

Authors, year	City, country	Type of study	N	Source of data
Berman et al. ¹⁹ , 1991	Not applicable	Analysis of prevention on subway system	Not applicable	KI
Clarke and Poyner ¹⁴ , 1994	London, UK	Field study of suicide prevention	Not applicable	FS, MSR, KI
Elzersdorfer and Sonneck ¹¹ , 1998	Vienna, Austria	Prospective observational study of media reporting	Not applicable	NR, FS
Elzersdorfer et al. ¹⁷ , 1992	Vienna, Austria	Study of suicide and media reporting	Not applicable	Not mentioned
Gershon et al. ² , 2005	Not applicable	Review of health and safety hazards of subways	Not applicable	Literature review
Guggenheim and Weisman ³¹ , 1974	Boston, USA	Follow-up on psychodynamics of attempters	51 attempts	CAS, AI, FI
Guth et al. ¹⁰ , 2006	New York City, USA	Study of demographics of injured presenting to hospital	14 attempts; 208 injured	TR, ED, OS
Lester ¹² , 1995	17 cities	Comparison of subway and national suicide rates	Not applicable	OS
Littmann ²⁰ , 1985	Toronto, Canada	Study of suicide and media reporting	Not applicable	MSR, NR
Maclean et al. ⁹ , 2006	New York City, USA	Study of demographics of subway-related traumas	5–11 attempts; 41 amputations	TR
O'Donnell et al. ¹⁸ , 1992	London, UK	Case report of attempter who was HIV+	Not applicable	CAS
O'Donnell et al. ¹⁶ , 1993	London, UK	Study on incidence of note-leaving	36 probable suicides and 36 probable attempts	MSR, TPR, SN
O'Donnell et al. ¹⁵ , 1994	17 cities	Editorial	Not applicable	MSR
O'Donnell et al. ³⁵ , 1994	London, UK	Follow-up on mortality of attempters	94 attempts	MSR, OS, DR, CR
O'Donnell and Farmer ¹³ , 1995	London, UK	Study of suicide statistics	242 probable attempts	MSR
O'Donnell et al. ³³ , 1996	London, UK	Follow-up on perspectives of attempters	26 attempts	AI, CI

AI interviewer interviews; CAS case report; CI clinical interviews; CR coroner's records; DR death registers; ED emergency department records; FI family member interviews; FS field study; HR hospital records; KI key informant interviews; MSR metro system records; NR newspaper reports; OS national or city-wide statistics; PI physician interviews; PR psychiatric records; SN suicide notes; TPR police or transit police records; TR trauma registry

Paris, San Francisco, Sao Paulo, Tokyo, Toronto, Tyne & Wear, Vienna).⁴ Each study was categorized as either, (1) a descriptive epidemiology study based on a consecutive series of suicide incidents in a given time period ($n=12$), (2) a follow-up study examining the motivation or long-term survival of attempters ($n=3$), or (3) a miscellaneous review or study on prevention, psychiatric aspects or statistics ($n=13$). The latter category included an editorial with useful statistical information, a review of safety on subway systems, a case report, statistical comparisons of suicide rates, and investigations of note-leaving behavior, media reporting, preventative approaches, psychodynamics of attempters and demographic data on injured patients.^{2,9-20}

After analyzing the literature and identifying the characteristics that appeared to be shared across studies, three categories were created: (1) individual characteristics (those that appear to be shared among suicides or attempters), (2) station characteristics (features of the station that appear to be related to the occurrence of suicide attempts), and (3) temporal characteristics (time periods during which higher or lower numbers of suicide incidents appear to occur).

Methodological Results

The duration of study in the majority of epidemiology studies was exceptionally long, with two thirds of studies having duration of 10 years or more (excluding the international review).^{3,21-28} The longest duration of study was found in an investigation of the London Underground that used data from 1940-1990.²⁷ As expected with studies of suicide incidents, sample sizes were relatively small, ranging from 13 to 207 suicides, and 22 to 323 suicide attempts.^{21,25,26} However, the aforementioned 50-year long study presented 3,240 suicide incidents.²⁷ Additionally, there was variation in the use of suicide, suicide attempts, and suicide incidents as the unit of measurement.

Incidence rates and prevalence were not given in most cases. Although most studies gave counts of suicide incidents during the period of study, these counts were not given relative to the number of riders who use the system. As the population at-risk is lacking, incidence rates and prevalence could not be derived. However, one commentary indicated a range of 0.2 to 1.8 suicide incidents per 10 million passengers across worldwide systems, with the Singapore Mass Rapid Transit system reporting no cases.¹⁵ A study of the Munich subway system found an incidence of 0.8 suicides per 100,000 inhabitants in 1999.³ Although outside the scope of this review, a previous review of the available data for hazards on subway systems found the occurrence of fatal accidents among passengers and subway workers to be rare.²

Most epidemiology studies used retrospective data that had been collected from incident reports recorded by transit authorities, police or emergency medical services.* Three studies in particular included data from the medical records of hospitals that specialize in injuries derived from the subway system, a high proportion of which were due to confirmed or suspected suicide attempts (75, 25, and 27%, respectively).^{9,10,29} One third (9/28) of all studies utilized medical, psychiatric or coroner's records in their analysis.

*Chowdhury et al.²¹ reported that the Calcutta system did not keep formal records of suicide incidents.

The case definitions used by different subway systems to identify a suicide or suicide attempt were not always mentioned. The lack of a common definition may result in misclassifications. In Montreal, for example, from 1986–1996, authorities recorded 362 cases of “preventative intervention” for persons who were “intercepted before a suicide attempt occurred.”²⁶ In turn, a count of suicide attempts will not include preventative interventions, regardless of the suicidal intent of the person involved. To compare, researchers of the London Underground defined a suicide incident more broadly as “any case of persons falling or jumping in front of a moving...train” as well as incidents involving persons found by the police on the tracks with no train present.²⁷ Moreover, the same authors found varying agreement between 242 suicide cases sourced from London Underground records and coroners’ verdicts that reported nonsuicide-related causes in half of men and one quarter of women.¹³

Few epidemiology studies used statistical analysis to establish the true risk associated with shared characteristics. As outlined by Kraemer et al.³⁰, risk factor status is indicated by a statistically significant association between a characteristic and its outcome, the characteristic’s precedence, and ascertainment of potency and definitions of high and low risk. Only the study of the Munich system used statistical analysis to broadly characterize the risks among the population.³ However, researchers may have forgone statistical analysis as subway suicide is a rare event and as researchers³ have emphasized, sample sizes of some studies are small. Furthermore, most researchers derived their data from incident reports that may not contain extensive information on characteristics that could be explored in risk factor research. Due to the methodological concerns, a review involving meta-analysis methods was not possible.

Descriptions of Subway Suicide in the Literature

Researchers have emphasized the distinctive behaviors and outcomes related to suicide on the subway. Trauma physicians have reported that amputations of extremities in survivors are common, and that while surviving patients do not frequently incur other life-threatening injuries, the amputations result in “long-term social, functional, and financial consequences.”⁹ Considering the immense physical forces involved, it is remarkable that case fatality rates across international systems show the method to rarely be lethal more than 60% of the time.⁴ Given this dichotomy, it is somewhat fitting that attempters have attributed their survival to supernatural interference.¹⁸ The event often occurs in a public setting, causing delays to transit service and leaving on-lookers and train operators distressed.³ While subway suicide commonly refers to individuals who jump in front of moving subway trains, authors have also described other types of suicidal behaviors, such as lying on the tracks in anticipation of a moving train and intentionally touching electrified rails.^{*21,31,32}

Several reasons for the use of subway methods have been suggested. Individuals may feel that they do not have to worry about having last-minute doubts or simply do not have available the privacy to use another method.^{14,31,33} Case studies give evidence that the method is often the culmination of a premeditated plan rather than an instantaneous decision, although this aspect deserves further investigation.³¹ Survivors have stated that the method was attractive due to their

*Rabban et al.³² describes a case series (N=16) of burn injuries from subway rails. As it describes forensic details of mainly occupational injuries, it did not meet the inclusion criteria.

understanding of an apparent high degree of lethality.³³ Rates within cities appear to be independent of national rates of all suicide methods. Using mean annual rates previously reported elsewhere, Lester¹² used a Spearman rank correlation coefficient to show that there was no association between subway rates in 17 cities and each city's corresponding national suicide rate in 1980. More recently, from 1980–1999, Ladwig and Baumert³ found a relatively stable incidence in Munich, which contrasted with the decreasing trend of all-cause suicide incidence within the city.

Individual Characteristics **Gender.** The finding of an increased number of suicides and suicide attempts by males was relatively consistent across studies, including the study that compiled data from 23 metro systems.⁴ Most studies with reasonably large samples ($N=56-129$) reported increased numbers of suicides among males, as compared to females, in the range of 1.58:1 to 2.5:1 (M:F).^{4,24,26,28} However, when compared to the gender distributions of suicide by all methods in Canada (3.54:1), UK (3.56:1), USA (4.23:1), and other Western countries, it appears that there is a smaller gender difference in suicides and attempted suicides using the subway method.³⁴

There was some evidence that the corresponding ratio for attempted suicides was lower than that of suicides. In three studies, where statistics for suicide and suicide attempts were reported separately, the ratio of attempted suicides by males as compared to females was lower than that of suicides.^{21,24,28} Finally, in a study of 94 surviving attempters, O'Donnell et al.³⁵ found nearly equivalent numbers of males and females. With respect to studies of overall suicide incidents, O'Donnell and Farmer²⁷ reported a higher proportion of males as compared to females (1.78:1) in a large sample ($N=2,847$) of suicide incidents on the London Underground from 1950–1990. However, Ladwig and Baumert³ found a difference in the gender distribution of suicide incidents (1.15:1) that was significantly smaller than that of all-cause suicides within Munich ($p=0.007$). In addition, Guggenheim and Weisman³⁶ documented almost equal numbers of males and females in a sample of 50 consecutive suicide incidents in Boston while Johnston and Waddell²⁵ found lower numbers of suicide incidents for men compared to women (0.71:1) in Toronto, from 1954–1980. Aside from these exceptions, it appears that males generally attempt and complete subway suicide more often than females, which is consistent with the trends for other violent methods³⁷.

Age. Most studies reported that the majority of victims who completed or attempted suicide were in the range of 20 to 30 years of age, but all age groups were usually represented in the statistics.^{3,4,25,27,28} Data from the Tokyo system showed a peak occurrence among individuals 51 to 60 years of age,⁴ and more generally, Chowdhury et al.²¹ and Mishara²⁶ reported that most suicide incidents involved those 40 years or younger. Seemingly, most suicides and attempted suicides occur among those 20 to 30 years of age, although it is not unusual to find older-aged individuals.

Marital Status and Place of Residence. According to the few studies that reported this information, the majority of suicides were single and lived alone at the time of suicide.^{26,36} Of a sample of 129 suicides, 60% were single, 24% were married, and 16% were widowed, separated, or divorced.²⁶ Guggenheim and Weisman³⁶ lend additional support by stating that of the 50 suicide incidents studied in Boston, 62% were unmarried at the time of the event. Moreover, in Mishara's²⁶ study, of a subsample of 112 suicides for which the information was available, 45% lived alone, 28% lived with family and 27% lived at a mental health facility at the time

of suicide. It is important to note that Mishara's broad definition of a mental health facility includes "psychiatric units of general hospitals, psychiatric hospitals and halfway houses with supervised living and therapeutic activities" (written communication, B. Mishara, January 2005). Overall, although many of the individuals were single and lived alone, it should be noted that 24% were married and 55% were living in group situations, which are still large proportions.²⁶

Substance Measures. Little information was reported on the involvement of alcohol or prohibited drugs in this population. In a subsample of 78 suicides for which the information was available, Mishara²⁶ reported that 25% had alcohol and 24% had drugs present in the bloodstream. However, the author noted that in both cases, the levels were not high and could include traces of prescription drugs used to treat mental illness. Maclean et al.⁹ stated that in a sample of 41 patients requiring traumatic amputations due to subway-related injuries (19% of which were ascertained to be suicide attempts and 22% indeterminate in the 27 patients for which this information was available) elevated alcohol levels above 100mg/dl were measured in 39% of individuals. Elsewhere, Cocks²⁹ reported that in a sample of 100 individuals injured in the London Underground, where deliberate self-harm was suspected in approximately 75%, 9% were shown by clinical or pathologist examination to have consumed substantial amounts of alcohol, and on-lookers judged 6% to have been "visibly drunk" before the event. Guggenheim and Weisman³⁶ found that 18 and 24% of the 50 suicide incidents studied suffered from acute and chronic alcoholism, respectively. It is notable that some authors of studies on railway suicide have suggested that raised blood alcohol levels of apparent suicides may suggest accidental circumstances and that mortality due to "train surfing," the phenomena of young persons clinging onto the outside of moving trains for fun, is often influenced by alcohol use.^{38,39}

Articulation of Intent. An individual's suicidal intent was not verifiable in many studies due to data collection techniques used by subway systems that may categorize all events involving individuals on tracks as either suicide incidents or accidents. Most studies did not include coroners' verdicts on cause of death or psychological autopsy information. However, several studies report that individuals may indicate a desire to attempt suicide before the suicide incident, although the indication may not specify use of the subway method. In a follow-up study of 20 survivors of attempts on the London Underground, O'Donnell et al.³³ used the Suicidal Intent Scale to show that 90% of these individuals felt certain that they would die using this method, more so than two samples of parasuicidal self-poisoners. This indicates an extraordinarily high degree of intent among this sample. Paradoxically, warnings of suicidal behavior appear to surface consistently before an attempt. In Mishara's²⁶ study, information on the past behaviors of 100 of 129 suicides was available: 81% expressed a desire to commit suicide and most had articulated their intent several times before suicide. In a subsample of 50 persons for which the information was available, 26 had expressed a desire to commit suicide on the day of the suicide incident and 21% of the original sample left a suicide note. Similarly, Cocks²⁹ showed that 15 of 100 patients injured on the London Underground articulated their intent during the 24 h preceding the incident. While both studies reported that intent was expressed, no specification of the subway as the desired method of suicide was stated.

Elsewhere, O'Donnell et al.¹⁶ found an incidence of note-leaving of 15% in a sample of 242 probable suicides and 138 probable suicide attempts on the London Underground. Upon analysis of 37 of the 42 available notes, they found that only

five notes stated an intention to use the subway method and of those, four notes mentioned a specific station for the attempt. Only 16 notes indicated or communicated the motive for the suicidal behavior. The investigators concluded that the notes provided little information describing the reasons for the suicidal behavior.

Psychopathology and Treatment. The majority of individuals who complete suicide appear to have serious mental illness at the time of suicide. Guggenheim and Weisman³⁶ stated that 75% of the 50 cases of suicide incidents had information in their hospital records that led the investigators to apply a psychiatric diagnosis. The most common diagnoses were affective psychosis (37%), neurosis (32%), schizophrenia (18%), and organic psychosis (13%). Mishara²⁶ revealed information on the psychiatric history of 122 of the 129 suicides: 86% of individuals had been previously diagnosed with mental illness. The most common primary diagnoses were depression (50%), schizophrenia (25.5%), and nonspecific psychosis (16.5%), all serious and chronic diagnoses. Johnston and Waddell²⁵ reported that 61% of 119 suicides in Toronto had a previous psychiatric history of depression (37%), schizophrenia (13.7%), paranoia (6.8%), or an undetermined psychiatric illness (42.5%). High proportions of diagnosed mental illness were also found in other studies.^{9,21,29,33}

Consistent with the high proportions of mentally ill persons in this population, many individuals were receiving some form of treatment at the time of suicide. Of 105 suicides diagnosed with mental illness, Mishara²⁶ found that approximately 72% were receiving either in-patient treatment or psychotropic medication at the time of suicide. Cocks²⁹ reported that in a 100-person sample, 58% received in-patient treatment at some time, 13% were in-patients at the time and 2% had been discharged from a psychiatric facility within 48 h of the incident. Similarly, using data on 26 attempters, O'Donnell et al.³³ found that 38% were psychiatric inpatients, 19% were receiving outpatient treatment, and 15% were being treated by general practitioners with antidepressants at the time of suicide. Diverging somewhat from these results, Johnston and Waddell²⁵ report that less than 6% of the 119 suicides examined were receiving in-patient treatment while less than 16% were receiving out-patient treatment at the time of suicide.

Previous Attempts and Subsequent Attempts. At least 20% of suicides appear to have had a previous attempt.^{25,26,29} Using a subsample of 88 suicides for which this information was available, Mishara²⁶ showed that 66% of suicides had at least one previous attempt (20.5% had one previous attempt, 22.7% had two previous attempts, and 22.7% had more than two previous attempts). Of importance, 12.5% of suicides had a previous attempt on the subway. In Johnston and Waddell's²⁵ study, 40% of the 73-person subsample of suicides made an unspecified number of previous attempts. Similarly, in Cocks²⁹ study, 39% of the 100 persons injured had made a previous attempt.

Regarding subsequent attempts, O'Donnell et al.³⁵ found that over a 10-year period, 9.6% (9/94) of survivors of attempts on the London Underground completed suicide, a figure comparable to rates of survivors of other methods. The investigators studied the records of 94 survivors whose index attempts occurred between 1977 and 1979. The index attempts resulted in a sudden increase in completed suicide in the short-term period of approximately 3 years, but this apparent risk did not endure in the long term. As only mortality data was analyzed, these figures do not account for nonfatal suicide attempts across the sample. Elsewhere, Guggenheim and Weisman³⁶ highlighted data on subsequent suicidal behavior by revealing that of 33 survivors in Boston, at least 21% attempted or completed suicide during 5.5 years of follow-up.

Station Characteristics Passenger Flow and Station Position. Sonneck et al.²⁸ found that the probability of suicide attempts increased with passenger flow at a particular station in Vienna. Importantly, the authors emphasize that although the “crowded, bigger” stations have a higher number of suicide incidents compared to smaller stations, the ratio of suicide incidents to the daily numbers of passengers was lower in larger stations. Elsewhere, during the years 1940–1989, suicide incidents on the London Underground were shown to be increased at stations with higher passenger flow (Spearman’s $r=0.7$).²³ In another paper describing the same records during the years 1940–1990, O’Donnell and Farmer²⁷ found that certain stations had suicide incidents in excess after controlling for passenger traffic. The authors reasoned that most of these stations were located in close proximity to psychiatric facilities and a high percentage of the victims were in-patients at the time.

Johnston and Waddell²⁵ stated that in Toronto, transfer stations (or stations where multiple lines converge) reported more suicide attempts because “they are accessible to more people”. As the Toronto Transit Commissions’ operating statistics show that transfer stations tend to experience the highest passenger flow,⁴⁰ the high absolute numbers of suicide attempts at these stations may be proportional to the passenger flow, and therefore, the ratio of attempts to passenger flow in a given period may be no higher than any other station. Elsewhere, Sonneck et al.²⁸ reported that terminal stations in Vienna were used less often for suicide incidents.

Proximity to Psychiatric Facility and Residence of the Victim. Several studies reported that stations with increased proximity to psychiatric facilities appear to have a higher occurrence of suicide incidents.^{23,25,27} O’Donnell and Farmer²⁷ rationalized that stations that had both a low passenger flow and a high absolute risk of suicide incidents tended to be located in close proximity to a psychiatric hospital. More generally, Johnston and Waddell²⁵ observed that more suicide incidents occurred at stations west of Toronto’s downtown core, proximal to two large psychiatric facilities. However, whether this is an experience found across systems is unclear. O’Donnell and Farmer⁴ reported that there was no consistency in this phenomenon across 23 systems. Of relevance, in a study of railway suicide in Southern England, Symonds⁷ suggested that correlations between high concentrations of suicide at a particular station and close proximity to psychiatric hospitals might be due to the fact that psychiatric facilities in the region were intentionally built near railway lines.

Information on the residence of the individual relative to the location of the station used to attempt suicide has seldom been addressed in the literature, although this may be an important determinant. Mishara,²⁶ based on the 127 individuals for whom this information available, reported that 70% of suicides on the Montreal system occurred at the station closest to the individuals’ place of residence. Similarly, Farmer et al.²³ stated that the stations that report a high number of suicide incidents have an increased proportion of victims with “no fixed abode.”

Station Design. There is much evidence that the physical design of stations presents the major determinant of the lethality of a suicide attempt. One such feature is the drainage pit, depressions of about 1 m in depth found beneath the rails of some subway stations on the London Underground.¹⁴ While the pits were designed to drain water from the tracks, they also decrease mortality due to the gap of space they provide below the tracks which prevents an attempter from making bodily contact with the train.²² In an observational study, Coats and Walter²² reported that from 1996–1997, there was a statistically significant reduction of 32% in the

mortality rate of persons who attempted suicide in London stations that contain drainage pits (44%) versus those that do not contain drainage pits (76%; $p=0.026$). The electrified third rail was referenced as a particularly lethal component of the track that causes severe electrocution, should bodily contact be made; this method factored in a disproportionate number of suicides (9/13) as compared to suicide attempts (3/22) on the Calcutta system.²¹ In addition, O'Donnell and Farmer⁴ showed that from 1973–1990, London subway lines that contain stations with pits have a statistically significant higher proportion of survivors (55%) compared to those that do not have pits (34%; $\chi^2=72.1$, $df=1$, $p<0.001$). The authors also showed that 87.4% of suicide incidents on the London Underground occurred on a platform, 9.1% occurred within a tunnel, and 3.4% occurred on the open track.²⁷ Furthermore, 40% of platform suicide incidents took place within 50 ft of the train's entrance point to the platform. The authors generally reported reduced mortality for individuals jumping farther from this point, where the train begins to slow its speed.

Temporal Characteristics Time of Day. Most suicide incidents tend to occur approximately between 1100 and 1600 hours.^{4,23–27,36} These times appear to coincide with the period between what are considered morning and afternoon rush hours in many cities worldwide. One divergent finding was that most suicide incidents occurred outside of these hours on the Calcutta system.²¹

The reporting of suicide during nondaylight hours is rare, possibly because most systems do not operate during much of the night. Guggenheim and Weisman³⁶ found that of the 50 suicide incidents examined in Boston, 12 alcoholics generally attempted suicide during night hours, from 1800 to midnight, while nonalcoholics generally attempted during daylight hours, from 0600 to 1800 ($\chi^2=7.51$, $p=0.01$).

Day of Week and Month of Year. Some studies reported an increased occurrence of suicide incidents on Mondays^{23,28} while a decreased occurrence of suicide incidents was reported on Sundays.^{3,23,27} There is extensive variation in the peak and trough months for suicide incidents across studies, and therefore, no evidence of a pattern related to the month of the year could be produced.

Temporal Phenomena: Placement of Media Reports and Economic Conditions. Studies have highlighted the relationship between the publication of suicide-related news reports and the occurrence of subway suicides. Littmann²⁰ found that from 1968–1973, slightly more reports were printed before a suicide incident than after, although the difference was not statistically significant. However, the researcher notes that article content was not analyzed and that overlap between the 'before' and 'after' periods of sequential suicides may have been overlooked by the methodology used. Elsewhere, Sonneck et al.²⁸ noted that the increase in subway suicides in Vienna, from 1984–1987, coincided with the unrestrained reporting of suicide in Austrian newspapers. Subsequent studies by the same team found that the establishment of voluntary media campaigns in 1987 to produce more responsible reporting practices correlated with a reduction in suicide incidents on the subway of more than 80% with rates remaining below pre-1987 levels during the study period.^{11,17}

Guth et al.¹⁰ analyzed the demographic information of 208 patients with subway-related injuries appearing at a New York City trauma center, from 1990–2003. The authors compared the data to measures of economic status (as defined by the city's unemployment and homeless rates) to find similar trends between all three curves. They reasoned that these ecological associations are suggestive of an

association between subway injuries and local economic conditions specifically among the groups they define as being at-risk: the psychiatrically impaired and unemployed. However, it must be noted that this study is based primarily on data on subway injuries and not specifically suicide incidents (25% of 56 individuals for whom the data were available were ascertained to have attempted suicide while this information is unavailable for the remaining 152 individuals).

DISCUSSION

Strengths and Limitations of the Review

The main goal of this review is to provide a starting point for clinical prevention by reviewing and analyzing the available research. Almost all of the epidemiology studies utilized study durations of 10 years or longer. However, they differed considerably in data collection methods, definitions used, and the amount of statistical analysis they employed. In addition, systems from developing countries were underrepresented, notwithstanding the international survey of 23 systems and the study of the Calcutta system.^{4,21}

Methodological Issues of the Studies

The most obvious methodological concern is the absence of statistical analysis across studies and the resulting lack of conclusive evidence regarding risk factors and their potency. Often, sample sizes were small and researchers may have been concerned that statistical results would not be trustworthy. However, the wealth of descriptive data and the long durations of investigation found across studies provide ample background information for future risk factor research.

Methods of data collection and operational definitions of suicidal behavior varied between studies with most authors relying on data from incident reports. Due to the secondary nature of data, it is difficult to verify suicidal intent in many studies. The use of a legal inquest system to ascertain and verify suicidal intent and occurrence of suicidal behavior, as found in the SOVRN railway suicide study, would offer a more uniform and valid data collection method.⁶ Furthermore, only one third of studies examined psychiatric characteristics, most probably due to the logistical and ethical challenges involved with the procurement of medical records. A study involving formal psychological autopsy techniques to identify the relationships between antecedent factors and suicides would provide an enriched level of insight into the subway method.

Main Findings

Across studies, characteristics related to gender, age, and psychopathology were frequently reported. In future studies, the documentation of in-depth characteristics such as place of residence and substance use at the time of the incident would be valuable. The studies reported remarkably similar findings, giving evidence that individuals who attempt suicide on the subway may present as a unique subgroup of suicidal individuals within urban regions (Table 3 shows the clustering of characteristics). The population appears to be young with a smaller gender difference as compared to the proportions for all causes of suicide. In addition, they appear to have a high level of lethal intent and they may express a desire to commit suicide before the actual incident. Suicide incidents may occur more frequently at the station proximal to individual's residence or psychiatric facility, on

TABLE 3 Shared characteristics of attempters

Characteristics
Male
20 to 30 years of age
Single or unmarried at the time of incident
Living alone
Receiving in-patient treatment
Serious and chronic mental illness
At least one previous attempt (sometimes involving the subway)
An expressed desire to commit suicide

a Monday and between 1100 and 1600 hours. This profile adds to what has been revealed by the most comprehensive previous studies^{4,27} by merging demographic data that describes the detailed characteristics of individuals involved (the presence of serious and chronic mental illness and its treatment, previous attempts, articulation of intent, marital status, living status) with previously reviewed data on age, gender and case-fatality rates.

Clinical Implications

Although further research is needed, the current findings may have some merit for clinicians working within mental health settings in urban regions. First, although the identified characteristics are known risk factors for suicidal behavior, the profile of suicidal young men with serious mental illness currently residing in a psychiatric facility in an urban region and with few resources to obtain means of suicide may be a particular subgroup where the risk of this method must be considered. Second, a small number of patients may become fixated on attempting suicide in the subway as their preferred method. It is important to note that a key finding of the SOVRN study of railway suicides in the UK was that persons who used the railway method tended to live close to the railway network.⁶ The authors reason that these individuals may know more about the locally pertinent means of suicide, such as a busy subway station. This strengthens the reasoning that patients may become fixated on the particular method. In certain cases, it might be justified to educate the individual that subway attempts are neither a quick nor certain means of suicide.

Mirroring this logic, voluntary media advisories on the reporting of suicide have been instituted in Montreal, Toronto and Vienna to target those individuals who may be stimulated by media stories to imitate the act.^{25,26,28} Media guidelines that de-emphasize the reporting of dramatic details about the suicide method appear to be effective in preventing suicides.⁴¹

Implications for Prevention in the Public Health Domain

The prevention of suicidal behavior on subway systems is essential for the protection of attempters, and certainly, the drivers and passengers who are exposed to the disturbing event. The detection of individuals who may be at risk

has several implications for preventing this method of suicide. The profile may be used to enrich gatekeeper-training programs for subway employees. Gatekeeper programs may be useful as employees often represent the last point of contact with attempters. As such, employees can be trained to identify and assist suicidal individuals by initiating relevant protocols and managing the situation until emergency services arrive. The recognition of warning signals of suicide, a core component of gatekeeper approaches, may be strengthened by the astute observations of the employees themselves. For example, Gaylord and Lester²⁴ describe staff and police in the Hong Kong subway as “sensitized” to a cluster of locally relevant indicators of suicidal intent, sourced through past observations. Such cues include removal of shoes, sudden dropping of belongings as the subway approaches, possession of sentimental items, avoidance of eye-contact and over-deliberate actions. Heightened staff vigilance within the station and on the platform through increased security officers and closed circuit television observation systems linked with staff may increase the difficulties for the attempter in following through with the act.^{2,19} These measures could also work to facilitate a liaison system between staff that enables the efficient commencement of safety protocols when a potential attempt is identified (such as an electronic signalling system to warn the driver in advance to stop the train).⁴

As the population may have a high degree of contact with mental health services and may themselves reside in mental health facilities, actions to monitor in-patient whereabouts and suicidal intent should take into account the susceptibility for subway suicide. For example, Clarke and Poyner¹⁴ have emphasized that psychiatric hospitals should consider a liaison system with nearby stations to forewarn subway personnel of potential attempts. O’Donnell and Farmer⁴ recall a similar situation where a psychiatric hospital located close to a railway where suicides were occurring moved its acute patients to another facility.

Structural modification of subway systems, including the pervasive installation of barriers and drainage pits, may be costly but may convey benefits otherwise difficult to obtain. As nearly all suicide incidents on the London Underground have occurred on a platform and 40% have occurred very close to the train’s entrance point to the platform, there are undoubtedly arguments for the erection of barriers for at least portions of the platform at existing stations and for full integration in the design of new stations and subway systems.^{4,27} This is best evidenced by stations in Bangkok, Paris, Singapore, and other cities that have unattached sliding door systems, which open only as the train stops moving.^{4,42} For older systems, installing these modifications may be structurally or financially impossible. Therefore, reducing the average speed of trains as they approach the platform to ease the halting of trains has been emphasized as a beneficial option.^{10,19,26}

Future Research

Clearly, there is a need for well-designed risk factor studies that utilize robust data-collection methods and statistical analysis to establish the true risk and potency associated with the reported characteristics. In addition, studies that examine differences in characteristics between suicides and suicide attempts would provide valuable insight. Given the challenges of performing such investigations, the success of future studies would necessitate extensive cooperation among subway officials,

law enforcement, clinicians, and other parties involved. Moreover, follow-up studies of subway suicide survivors are extremely valuable as they may provide a faithful perspective into the motivations and intentions of individuals who engage in suicidal behavior on the subway.

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