Turkish Journal of Trauma & Emergency Surgery
Original Article

Ulus Travma Acil Cerrahi Derg 2011;17 (5):440-444
Klinik Çalışma
doi: 10.5505/tjtes.2011.66750

10-year evaluation of train accidents

Tren kazalarının 10 yıllık değerlendirilmesi

Meltem AKKAŞ,[1] Didem AY,[2] Nalan METİN AKSU,[1] Müge GÜNALP[3]

BACKGROUND

Although less frequent than automobile accidents, train accidents have a major impact on victims' lives.

METHODS

Records of patients older than 16 years of age admitted to the Adult Emergency Department of Hacettepe University Medical Center due to train accidents were retrospectively evaluated.

RESULTS

44 patients (30 males, 14 females) with a mean age of 31.8±11.4 years were included in the study. The majority of the accidents occurred during commuting hours. 37 patients were discharged, 22 of them from the emergency department. The mortality rate was 7/44 (16%). Overall mean Revised Trauma Score (RTS) was 10.5 (3 in deaths and 11.9 in survivors). In 5 patients, the cause of death was pelvic trauma leading to major vascular injury and lower limb amputation. In 1 patient, thorax and abdomen trauma and in 1 patient head injury were the causes of mortality. Primary risk factors for mortality were alcohol intoxication (100%), cardiopulmonary resuscitation on admittance (100%), recurrent suicide attempt (75%), presence of psychiatric illness (60%), and low RTS.

CONCLUSION

In this study, most train accidents causing minor injuries were due to falling from the train prior to acceleration. Nevertheless, train accidents led to a mortality rate of 16% and morbidity rate of 37%. These findings draw attention to the importance of developing preventive strategies.

Key Words: Train accident/mortality/morbidity.

AMAÇ

Otomobil kazaları ile karşılaştırıldığında tren kazaları daha az görülmekle beraber, kazazedelerin hayatları üzerinde ciddi etkisi vardır.

GEREÇ VE YÖNTEM

Hacettepe Üniversitesi Tıp Fakültesi Hastanesi Acil Kliniğine başvuran 16 yaş üzerinde, tren kazasına maruz hastaların dosyaları geriye dönük olarak incelendi.

BULGULAR

30 erkek, 14 kadın toplam 44 hastanın yaş ortalaması 31,8±14,3 idi. Yaralanmaların çoğu işe gidiş-çıkış saatlerindeydi. Yirmi ikisi acil servisten olmak üzere toplam 37 hasta taburcu edildi. Mortalite 7/44 (%16) saptandı. Revize travma skoru (RTS) ortalama 10,5 olup, ölenlerde 3, yaşayanlarda 11,9 idi. Ölüm nedeni 5 hastada majör vasküler hasar ve alt ekstremite amputasyonuna yol açan pelvik travma, 1 hastada torakal ve abdominal travma, 1 hastada kafa travması idi. Mortalite için primer risk faktörleri; alkollü olmak (%100), başvuru anında kardiyopulmoner resüsitasyon yapılması (%100), tekrarlayan intihar girişimi (%75), psikiyatrik hastalık öyküsü (%60) ve düşük RTS puanı idi.

SONUÇ

Tren kazalarının çoğunluğunu, yeterince hız kazanmamış trenden kaza ile düşmeye bağlı oluşmuş minör yaralanmalar oluşturmaktadır. Buna rağmen tren kazaları %16 mortalite ve %37 morbiditeye neden olmuştur. Bu bulgular yaralanmaları önleyici tedbirlerin geliştirilmesinin önemine dikkat çekmektedir.

Anahtar Sözcükler: Tren kazası/mortalite/morbidite.

[1]Department of Emergency Medicine, Hacettepe University Faculty of Medicine, Ankara; [2]Department of Emergency Medicine, Yeditepe University Faculty of Medicine, Istanbul; [3]Department of Emergency Medicine, Ankara University Faculty of Medicine, Ankara, Turkey.

[1]Hacettepe Üniversitesi Tıp Fakültesi, Acil Tıp Anabilim Dalı, Ankara; [2]Yeditepe Üniversitesi Tıp Fakültesi, Acil Tıp Anabilim Dalı, İstanbul; [3]Ankara Üniversitesi Tıp Fakültesi, Acil Tıp Anabilim Dalı, Ankara.

Correspondence *(İletişim):* Meltem Akkas, M.D. Hacettepe University School of Medicine, Emergency Department, Sıhhıye, Ankara, Turkey.
Tel: +90 - 312 - 305 25 05 e-mail *(e-posta):* meltemakkas@hotmail.com

Railway transportation is especially preferred in underdeveloped countries like South Africa and India. However, it is also a common transportation form in developed countries due to its low cost. The fatality rate is about 60 per 100 million passengers a year in South Africa and 150 in India.[1,2] Railway-related accidents result in 18,000 injuries and 1,200 fatalities annually in the United States.[3] In Turkey, the approximate annual fatality rate is 213 per 100 million passengers.[4] This rate is higher than the rates in developed and developing countries.

When compared with automobile accidents, railway accidents are rare; nevertheless, they are morbid, commonly debilitating and frequently fatal.[5-10] The literature related to railway accidents is limited in our country as in the rest of the world.

The Medical Center of Hacettepe University is one of four hospitals located near the train station. Many employees use this station for daily transport from suburban areas since the station is located in the city center. Due to the close proximity of the railway station to our hospital, railway accidents and injuries are usually admitted to this center.

The present study aimed to evaluate the demographic and clinical features of victims and the causes and outcomes of train accidents.

MATERIALS AND METHODS

We retrospectively analyzed patients who presented to the adult Emergency Department of Hacettepe University Medical Center from January 1, 1998 to January 31, 2008 due to railway accidents. All encountered patients were above the age of 16 years. A total of 51 patients were admitted due to railway accidents. The records of 7 patients could not be obtained, and they were excluded from the study.

Railway accidents were evaluated in three groups as: train-train collisions or overturned train, train-motor vehicle collision and train-pedestrian collision. Train-pedestrian collisions were grouped as suicides, accidental train-pedestrian collision, stepping off a train, and falling from a train. We also searched for the velocity of the train in the patient records.

Demographic characteristics of victims, causes of injuries, morbidities, and mortalities were evaluated. Categorical data were given as frequencies and percentages.

RESULTS

Of the evaluated patients, 30 (68%) were male and 14 (32%) were female. The mean (range) age of patients was 31.8±14.3 years. Accidents occurred between 16:00 - 19:00 in 18 (41%) patients and between 06:00 - 09:00 in 9 (20%) patients.

The time elapsed from accidents to admittance to hospital was <15 minutes (min) in 22 patients, 15-29 min in 17 patients and >60 min in 1 patient.

With respect to the causes of injuries, no relevant case regarding overturned train or train-train collision was determined. There were 2 cases (4.5%) of train-motor vehicle collision, and 42 cases (95.5%) of train-pedestrian collisions.

Of the train-pedestrian crashes, 26 cases were due to accidental fall while the train was slowing down or gathering speed, 8 cases were suicidal, 4 cases were due to train-pedestrian collision while accelerating, and 4 cases were due to jumping from train while it was moving (Table 1).

Of the 8 suicidal cases, 5 jumped from the train, 2 threw themselves in front of a moving train, and 1 was lying on the railways. Two cases were found to have alcohol in the blood. Both had a history of psychiatric illness and committed suicide. Apart from these 2 cases, 3 additional cases had a history of some psychiatric illnesses. Of the 5 cases who had a history of psychiatric illness, 4 committed suicide and 1 was an accidental injury.

Table 1. Causes of injuries

Causes of injuries	Total (n)	Total age	Male (n)	Male age	Female (n)	Female age
Overturned train	0 (0%)	–	–	–	–	–
Train-train collision	0 (0%)	–	–	–	–	–
Train-motor vehicle collision	2 (4.5%)	33±16.9	2 (4.5%)	33±16.97	–	–
Train-pedestrian collision	42 (95.5%)	31.7±14.3	28	33.6±15.7	14	27.8±10.6
a) Accidental fall while train was slowing down or gathering speed	26	31,4±15	12	36±17.7	14	27.8±10.6
b) Suicide	8	36.8±13.3	8	36.8±13.3	–	–
c) Train-pedestrian collision while accelerating	4	31±18.1	4	31±18.1	–	–
d) Jump from train while moving	4	23±11.4	4	23±11.4	–	–
Total	44	31.8±14.3	30	33.7±15.5	14	27.8±10.6

Four cases had a previous history of suicidal attempt, all of whom had an accompanying psychiatric illness. Two of them had selected the train in previous suicide attempts.

Accompanying system/organ injuries included: 16 soft tissue injuries, 1 sternum fracture, 1 clavicle fracture, 7 rib fractures, 4 hemothorax, 6 pneumothorax, 3 pulmonary contusion, 14 lower limb fractures, 3 upper limb fractures, 12 lower limb amputations, 2 upper limb amputations, 2 intracranial hemorrhages, 5 vertebral fractures, 8 pelvic fractures, 3 intraabdominal bleeding, 5 major blood vessel injury, 4 maxillofacial injury, and 1 renal injury. A total of 19 limb amputations were performed in 14 patients: 8 leg, 5 thigh, 4 ankle, and 2 finger amputations.

Although 6 of the amputations were subtotal, all had Mangled Extremity Severity Score (MESS) of >7, and therefore no amputated part could be saved.

The overall mean Revised Trauma Score (RTS) was 10.5; 3 in deaths and 11.9 in survivors.

The mortality rate was 7/44 (16%). Cardiopulmonary arrest was present on admission in 1, and 6 patients died within 3 hours of arrival. In all mortalities, accidents were between 16:30-19:30. All deaths were resuscitated. In 5 patients, the cause of death was pelvic trauma leading to major vascular injury and lower limb amputation. In 1 patient, thorax and abdominal trauma and in 1 patient head injury were the causes of mortality.

Causes of trauma in the mortal cases were train-motor vehicle collision in 2 cases and train-pedestrian collision in 5 cases (Table 2).

The remaining 37 survivors did not need resuscitation. Eighteen cases required liquid or blood products replacement therapy.

Alcohol intoxication (100%), cardiopulmonary resuscitation on admittance (100%), recurrent suicide attempt (75%), presence of psychiatric illness (60%), and low RTS were related with high mortality.

A total of 37 patients were discharged, 22 of them from the emergency department. Of those 22 patients discharged from the emergency department, 16 had soft tissue injury and 6 had isolated bone fractures. These 6 isolated bone fractures were as follows: 2 closed extremity fractures, 2 pelvic fractures, 1 vertebra fracture, and 1 maxillofacial injury. Distribution of patients according to departments of hospitalization was as follows: 9 orthopedics and traumatology, 4 general surgery, 1 plastic and reconstructive surgery, and 1 neurosurgery. Mean duration of hospitalization was 15.7 (min 1-max 180) days.

DISCUSSION

Train accidents have a high impact in both human and financial terms. Although train accidents result in no serious injury in general, they may cause death or high morbidity such as amputations of limbs.[7,11] In the United States, they cost more than $300 million.[11] Data regarding characteristics of train accidents are scarce. In this study, we present our experience with respect to the clinical features of train accidents and their outcomes, with the hope to contribute to the literature.

In accordance with the previous studies, the majority of the accidents occurred during commuting hours, and the majority of the victims were male, implying that train accidents are closely related to being en route to business or during rush hours.[4,5,12-17] A previous study from our region also reported a peak number of accidents during commuting hours.[18] Thirty-six cases (81%) were brought to the emergency department within 30 min. Delayed arrival was mostly due to transportation of victims from accidents occurring at stations remote from our hospital. Along with the improvement in ambulance services in our country during recent years, the lag time has considerably shortened with respect to that in the past, when the transportation of patients was largely dependent on non-organized transportation with private vehicles.

Train-pedestrian collisions are less common than other forms of pedestrian accidents such as pedestrians-motor vehicle collisions on the roads. However, they are more likely to result in death or irreparable

Table 2. Causes of death

Causes of death	Death (n)	Death age	Male (n)	Male age	Female (n)	Female age
Train-motor vehicle collision	2	33±16.9	2	33±16.9	–	–
Train-pedestrian collision	5	39.8±14.5	4	37.7±15.9	1	48
a) Accidental fall while train was slowing down or gathering speed	1	48	–	–	1	48
b) Suicide	3	38±20.2	3	38±20.2	–	–
c) Train-pedestrian collision while accelerating	1	37	1	37	–	–
Total	7	37.8±14.1	6	36.1±14.6	1	48

damage, such as extremity amputations or paralysis.[1,3,8,19,20] The kinetic energy transferred by a moving train to a pedestrian is proportional to the mass and velocity of the train. Therefore, an enormous amount of energy is transferred to the body during impact, resulting in massive injuries and a high mortality rate.[18] In accordance with the previous reports, falling from a train was a common form of train-pedestrian collision in our study population.[13,18,19] Accidents of this type mostly resulted in non-serious injuries, likely due to their occurrence before acceleration. This observation was supported by the findings of Goldberg et al.,[3] who reported that train accidents do not always cause considerable morbidity or mortality.

The injuries as described by previous studies were mostly soft tissue injuries and uncomplicated bone fractures.[14,21-23] The mean mortality rate in our study was 16%. The highest mortality rate among the victims of train-motor vehicle collisions, at 100%, supports the findings of previous reports.[18,24] Meanwhile, the mortality rate among suicide attempts was 37.5%. Train accident-related fatalities vary between 12% - 75%, irrespective of whether the cause is a fall or suicide attempt. In our study, 4 of 5 (80%) suicidal cases had a history of psychiatric illness as well as of previous suicide attempts, suggesting a true suicide. Some intoxicated cases might be misleadingly reported as suicide, when in fact the fall may have been accidental.[1,15,18,19]

Mortality and morbidity related with accidents usually correlate with MESS and Injury Severity Score (ISS).[3,13] We also found that RTS was positively correlated with mortality and morbidity. Pelvic trauma causing major vessel injury associated with lower limb amputations was the major cause of mortality in our study. Thirty-two percent (14/44) of our cases underwent amputations. Traumatic amputations are more common in train accidents than in motor vehicle accidents. Lower limb amputations are encountered mostly.[3-5,11] Amputation rates in the literature vary between 35% - 82%[3,5,16,23] and head, thorax and abdominal injuries to a lesser extent.[11] Amputations associated with higher MESS could not be saved.[3]

Alcohol intake is common in train accidents.[1,5,7,13,15,17,23,25] and intoxication is related with a mortality rate of 80%.[15] Although the frequency of alcohol intoxication was low in our study, with a rate of 4.5%, likely as a result of the low alcohol consumption in our population, among the 7 deaths, 2 of them were intoxicated (28%). Symonds[26] identified alcohol as a major risk factor, but he stated that alcohol contributed less in railway-related suicides than in non-railway related suicides.

Authorities have been forced to take measures to improve railway safety.[18] Causes of train-pedestrian accidents vary with social, geographic and cultural backgrounds. Therefore, precautions to be taken need to be addressed on the basis of these factors. Train-pedestrian collisions can partially be reduced by environmental modifications such as warning devices and protection systems.[27,28] It was reported that unsafe behavior may be unintentional due to errors in perception, knowledge or judgement.[27,29]

In fact, research on interventions to reduce train-pedestrian accidents is very limited. Various authors have proposed interventions such as limitation of pedestrian access to the rail corridor, public education about risk and illegality, or reward or punishment for safe and unsafe railway crossing behavior, as means to prevent unsafe pedestrian railway crossing behavior, but few have evaluated the efficacy of any of these interventions.[1,11] Rail safety education in school and punishment for every unsafe crossing were associated with significant decreases in unsafe crossing compared with that observed prior to any intervention. General discussions about rail safety were not associated with significant decreases in unsafe crossing.[17]

In conclusion, mostly musculoskeletal injuries and amputations are seen in train accidents. It should be noted that these kinds of injuries could cause serious morbidity and mortality. To prevent accidents, public education should be continuous and preventive measures should be taken.

REFERENCES

1. Lerer LB, Matzopoulos R. Meeting the challenge of railway injury in a South African city. Lancet 1996;348:664-6.
2. Rautji R, Dogra TD. Rail traffic accidents: a retrospective study. Med Sci Law 2004;44:67-70.
3. Goldberg BA, Mootha RK, Lindsey RW. Train accidents involving pedestrians, motor vehicles, and motorcycles. Am J Orthop (Belle Mead NJ) 1998;27:315-20.
4. Agalar F, Cakmakci M, Kunt MM. Train-pedestrian accidents. Eur J Emerg Med 2000;7:131-3.
5. Shapiro MJ, Luchtefeld WB, Durham RM, Mazuski JE. Traumatic train injuries. Am J Emerg Med 1994;12:92-3.
6. Kligman MD, Knotts FB, Buderer NM, Kerwin AJ, Rodgers JF. Railway train versus motor vehicle collisions: a comparative study of injury severity and patterns. J Trauma 1999;47:928-31.
7. Moore TJ, Wilson JR, Hartman M. Train versus pedestrian accidents. South Med J 1991;84:1097-8, 1102.
8. Evans AW. Accidental fatalities in transport. J. Royal Stat Soc Series A (Statistics in Society) 2003;166:253-60.
9. Miller TR, Douglass JB, Pindus NM. Railroad injury: causes, costs, and comparisons with other transport modes. J Safety Research 1994;25:183-95.
10. Matzopoulos R, Peden M, Bradshaw D, Jordaan E. Alcohol as a risk factor for unintentional rail injury fatalities during daylight hours. Int J Inj Contr Saf Promot 2006;13:81-8.
11. Blazar PE, Dormans JP, Born CT. Train injuries in children. J Orthop Trauma 1997;11:126-9.
12. Bloch-Bogusławska E, Engelgardt P, Wolska E, Paradowska A. Analysis of deaths caused by rail-vehicles in the mate-

rials collected by the Department of Forensic Medicine in Bydgoszcz in the years 1992-2002. Arch Med Sadowej Kryminol 2006;56:181-6. [Abstract]
13. Spaite D, Criss E, Valenzuela T, Meislin HW, Ogden JR. Railroad accidents: a metropolitan experience of death and injury. Ann Emerg Med 1988;17:620-5.
14. Kong LB, Lekawa M, Navarro RA, McGrath J, Cohen M, Margulies DR, et al. Pedestrian-motor vehicle trauma: an analysis of injury profiles by age. J Am Coll Surg 1996;182:17-23.
15. Cina SJ, Koelpin JL, Nichols CA, Conradi SE. A decade of train-pedestrian fatalities: the Charleston experience. J Forensic Sci 1994;39:668-73.
16. Chattar-Cora D, Tutela RR Jr, Daum AN, Cromack DT. Experience with railroad injuries at a major urban trauma center serving the United States-Mexico border. J Trauma 2007;62:1123-6.
17. Lobb B, Harré N, Terry N. An evaluation of four types of railway pedestrian crossing safety intervention. Accid Anal Prev 2003;35:487-94.
18. Ozdoğan M, Cakar S, Ağalar F, Eryilmaz M, Aytaç B, Aydinuraz K. The epidemiology of the railway related casualties. Ulus Travma Acil Cerrahi Derg 2006;12:235-41.
19. Nixon J, Corcoran A, Fielding L, Eastgate J. Fatal and nonfatal accidents on the railways-a study of injuries to individuals, with particular reference to children and to nonfatal trauma. Accid Anal Prev 1985;17:217-22.
20. Smith G. Incidents involving trains. J Emerg Care 1995;2:30-4.
21. Singer G, Thordarson D. Train-versus-pedestrian injuries. Orthopaedic management. Orthop Rev 1994:Supp:30-4.
22. Isenberg JS. Boxcar heel: an unusual etiology of hindfoot amputation requiring microvascular reconstruction. J Foot Ankle Surg 1998;37:165-8.
23. Moody DE, Crouch DJ, Smith RP, Cresalia CW, Francom P, Wilkins DG, et al. Drug and alcohol involvement in railroad accidents. J Forensic Sci 1991;36:1474-84.
24. Gitelman V, Hakkert AS. The evaluation of road-rail crossing safety with limited accident statistics. Accid Anal Prev 1997;29:171-9.
25. Pelletier A. Deaths among railroad trespassers. The role of alcohol in fatal injuries. JAMA 1997;277:1064-6.
26. Symonds RL. Psychiatric and preventative aspects of rail fatalities. Soc Sci Med 1994;38:431-5.
27. Ward NJ, Wilde GJ. Field observation of advance warning/advisory signage for passive railway crossings with restricted lateral sightline visibility: an experimental investigation. Accid Anal Prev 1995;27:185-97.
28. Wigglesworth EC. A human factors commentary on innovations at railroad-highway grade crossings in Australia. J Safety Research 2001;32:309-21.
29. Lobb B, Harre N, Suddendorf T. An evaluation of a suburban railway pedestrian crossing safety programme. Accid Anal Prev 2001;33:157-65.