

Electrical fatalities in Ankara over 11 years

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Aim: Electrical injuries are still responsible for significant morbidity and mortality; however, they are generally preventable with simple safety measures. This study aims to determine the general features of electrical fatalities, and to draw attention of health professionals towards such preventable deaths.

Materials and methods: A retrospective evaluation of records of electrocution-related deaths in Ankara, Turkey, was conducted over 11 years (1998-2008).

Results: Out of 12,263 autopsy cases, 100 (0.8%) were secondary to electrocution. Most of the victims were male (n = 94; 94%) while only 6 were female. Victims' age ranged from 1 year to 76 years, with a mean age of 33.5 years. Entry lesions were localized on the upper extremities in the majority of cases (n = 74; 74%). However, no electrical lesions were found in 3 cases. Of all cases, 71 (71%) occurred as occupational accidents, mostly seen in workplaces. There was an increase in electrical fatalities in the summer (n = 58, 58%). Accompanying traumatic lesions were detected in 30 (30%) cases. All of the deaths were recorded as accidental except for one suicidal death.

Conclusion: The overwhelming majority of electrical fatalities were occupational-related, which were mostly preventable. Proper installation and maintenance of electrical devices will help to tackle electrical injuries at home and in the workplace. Additionally, educational programs for workers and employers should be provided and public and occupational safety measures should be promoted by the authorities.

Key words: Electrocution, occupational accident, death, autopsy, forensic medicine, Ankara

Ankara'da elektrik çarpmasına bağlı ölümler; Onbir yıllık veriler

Amaç: Elektriğe bağlı yaralanmalar her ne kadar basit güvenlik önlemleriyle önlenabilir olsa da, hâlâ önemli derecede morbidite ve mortalite sebebidir. Bu çalışmada, elektrik çarpmasına bağlı ölümlerin genel özellikleri ile bu önlenbilir ölümlere dikkat çekilmesi amaçlanmıştır.

Yöntem ve gereç: Ankara ilinde 11 yıllık dönemde (1998-2008) elektrik çarpmasıyla ilişkili ölümlere ait kayıtlar retrospektif olarak taranarak değerlendirme yapılmıştır.

Bulgular: Otopsi yapılan 12.263 ölüm olgusundan yalnızca 100'ü elektrik çarpmasına bağlıydı. Olguların 6'sı kadın, 94'ü erkekti (n = 94; % 94). Yaş aralığı 1 ile 76 arasında değişmekle beraber ortalama yaş 33.5 idi. Giriş lezyonu 3 olguda tespit edilemedi ancak olguların çoğunda (n = 74; % 74) üst ekstremitelerde bulunmaktaydı. Olguların % 71'i iş kazası olarak değerlendirildi ve bunların çoğunluğu işyerinde meydana gelmişti. Yaz aylarında elektriğe bağlı ölümlerin daha sık olduğu görüldü (n = 58; % 58). Otuz olguda elektrik çarpmasına eşlik eden travmatik lezyon tespit edildi (n = 30; % 30). Bir intihar olgusu dışında, tüm ölüm olgularının orijininin kaza olduğu görüldü.

Sonuç: Elektriğe bağlı ölümlerin önemli bir kısmı mesleki olup çoğunlukla önlenabilir ölümlerdi. Uygun tesisat kurulumu ve elektrik cihazlarının düzenli bakımı, işyeri ve evde elektrik yaralanmalarıyla baş etmede yardımcı olacaktır. Ayrıca, yetkililer tarafından işveren ve işçilere yönelik eğitim programlarının düzenlenmesi ve işyeri güvenlik tedbirleri konusunda düzenlemeler yapılması gerekmektedir.

Anahtar sözcükler: Elektrik çarpması, iş kazası, ölüm, otopsi, adli tıp, Ankara

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Introduction

Although electricity is in widespread use as an energy source, electrocution is a rare cause of death and is mostly accidental (1-3). Electrical injuries are mostly accidental but suicidal and homicidal cases have also been reported (1).

Deaths related to electricity are usually preventable as they are mostly caused because of carelessness and poor maintenance of electrical equipment (4,5). Although accidental electrocutions are reported rarely in developed countries, electrocution takes place among leading causes of occupational deaths in the United States with an average of one death per day in the workplace (6,7). A study from South Australia reported an average of 3.2 electrical deaths per year (8). In Sweden, accidental electrocutions have been on a decreasing trend over 25 years, proving that preventive strategies to reduce electricity-related fatalities were effective (9).

This study aimed to determine the general features of electrical fatalities and to draw attention of health professionals towards such preventable deaths, as well as to notify authorities and public through educational programs.

Materials and methods

The records of autopsies ($n = 12,263$) performed between 1998 and 2008 in the Morgue Department, Council of Forensic Medicine, Ankara Group Administration were examined retrospectively. One hundred deaths were determined as electrocution related based on autopsy findings, crime scene investigations, and further examinations. These cases were examined with regard to gender, age, time of death, localization of the injuries, toxicological analyses, and voltage properties.

The statistical analyses were performed with SPSS for Windows 16.0. Chi-square test was used in order to compare traumatic lesions in high and low voltage cases.

Results

During the studied 11-year period, electrical fatalities comprised 0.8% ($n = 100$) of all autopsies ($n = 12,263$). The victims of electrocution were overwhelmingly

male ($n = 94$; 94%) while only 6 were female. The victims' age ranged from 1 year to 76 years, with a mean age of 33.5 years; however, most of them ($n = 53$, 53%) were between 21 and 40 years old. Of all victims, 17 were under the age of 18 and 10 of these were laborers from various fields. On the other hand, 7 victims were under 10 years of age (Table 1).

The majority of incidents ($n = 58$; 58%) occurred in the summer, while the lowest number of deaths encountered in winter (Figure 1). There was only one case in January, which is the month in which the fewest electrocutions occurred. The number of cases was highest in 2006, with 19 (19%) (Figure 2).

A great number of deaths ($n = 61$, 61%) were caused by low voltage electrocution, followed by high voltage electrocution ($n = 35$; 35%) and lightning ($n = 3$; 3%) (Table 2).

Out of the 100 cases, 71 (71%) occurred as occupational accidents mostly seen in workplaces, such as construction zones, near aerial power lines, or factories. Of the remaining, 19 cases occurred at home while few cases occurred in various other places. The places of incidents are shown in Table 3. All deaths were recorded as accidental except for one victim, who committed suicide. Most of the victims of occupational accidents were construction workers ($n = 21$) and electric technicians ($n = 19$). The main causes of deaths were electrocution in 95 cases, followed by falling from a height (4 cases) and drowning after electrocution (1 case).

Table 1. Case distribution by age and gender.

Age (years)	Gender		Total
	Male	Female	
0-10	7	-	7
11-20	14	1	15
21-30	28	-	28
31-40	22	3	25
41-50	15	2	17
51-60	4	-	4
61 and ↑	4	-	4
Total	94	6	100

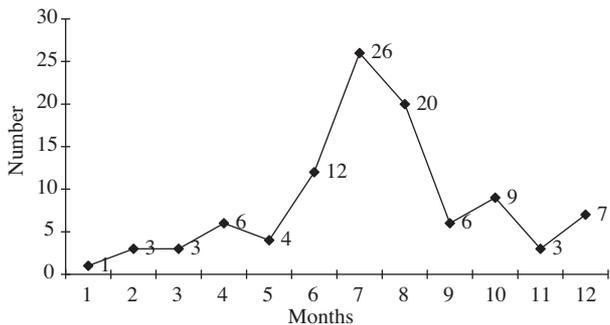


Figure 1. Case distribution by month.

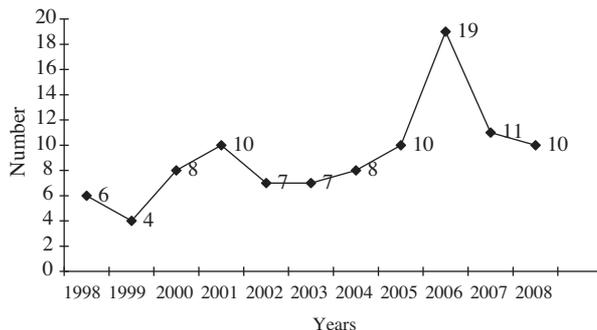


Figure 2. Case distribution by years.

Table 2. Case distribution by type of voltage.

Voltage of electricity	n	%
Low voltage	61	61
High voltage	35	35
Other*	4	4
Total	100	100

* Lightning and unknown

Entry lesions were localized on upper extremities in the majority of cases (n = 74; 74%). However, no electrical lesions were found in 3 cases (Table 4). In 77 cases, the lesions were confirmed as electrical burns by histological studies. Apart from entry lesions, large electrical burns covering the whole body were noted in a low voltage related death in which the victim was found in a bath. Additionally, in 10 cases (n = 35; 28.5%) of high voltage, spark lesions were detected.

Accompanying traumatic lesions were found in 30 cases. In 16 cases (16%), falling from height was secondary to electrocution and in 4 of them falling from height was the main cause of death.

Table 3. Case distribution by incident places.

Place	Occupational (n)	Leisure (n)	Total (n)
Home	1	18	19
Workshop/Industry	17	0	17
Water area	4	0	4
Field	9	1	10
Construction site	21	0	21
Power line pole	17	5	22
Hotel	0	2	2
Military area	2	0	2
Unknown	0	0	3
Total	71	26	100

Table 4. Distribution of entry lesions by body parts.

Entry Lesions	Cases	
	Number	%
Head & neck	9	9
Thorax & back	4	4
Abdomen	1	1
Upper limb	74	74
Lower limb	9	9
No lesion	3	3
Total	100	100

A complete toxicological examination did not show trace of drugs in any cases. However, toxicological analyses revealed a blood alcohol concentration ranging between 8 and 84 mg/dL in 23 cases. Of these alcohol positive cases, 17 were occupational accidents.

Discussion

A review of the literature showed that the frequency of electrical related fatalities varies, ranging from 20% to 81% (10-13). Similar to a previously conducted study by Canturk et al. in our region, it was observed in the present study that electrocution-related deaths constitute 0.8% of all autopsies performed in Ankara.

The present study shows that accidental deaths form the greatest proportion of the presented series, which is similar to the previous literature (1,14). There was only one suicidal electrocution (2.3%) and no homicidal cases in our series. The frequency of suicide was lower than that reported from Northern Ireland (1).

The overwhelming majority of the victims were males aged between 21 and 40 years, similar to previous studies (1,7,9). There was no occupational death among females. This might be a consequence of the higher rate of male employees in electric works, construction or in industries with high electrocution risk. This finding is similar to data from the United States, Sweden, and Australia (7,9,15,16). The study from Sweden showed that the incidence of electricity-related fatalities had decreased steadily since preventive measures had been increased. Accordingly, although there is not a yearly decrease in the number of electricity-related deaths, it can be claimed that preventive measures are not adequate to tackle electrical fatalities in Ankara.

In accordance with previous studies, most of the deaths occurred in summer in our study (1,7,9,17,18). The increase in the number of deaths in summer is probably related to the increase in the number of constructions in this period (1,19).

The highest rate of electrocution related death occurred among electric-related professions in accordance with previous studies (7,9,16) and the number of deaths among construction workers was very high in our study, which is similar to results from the United States (7). It is probably because the

Table 5. Distribution of type of voltage by existence of accompanying traumatic lesion.

	Traumatic lesion (+)	Traumatic lesion (-)	Total
Low voltage	9	52	61
High voltage	21	14	35
Lightning	0	3	3
Total	30	69	99

* Voltage degree is unknown for one case

construction sites lack preventive measures in Turkey. Unfortunately, construction workers are mostly occupied seasonally and have a lack of experience in this country (19). There was not a decreasing trend for electrocution related deaths unlike Sweden (9), which might indicate that the occupational sector does not take sufficient precautions in Turkey.

Among the victims of high voltage electrocution, 7 were not electricians. Of these, 5 victims were reported to have been trying to fix the breakdown of the electricity. One victim, a villager, climbed a utility pole to watch his animals, and lastly one victim was a child who died while he was playing with his friends near a substation. All these examples show the importance of public education about measures to be taken.

Out of all, accompanying traumatic lesions were found in 30 cases (30%). In this study small bruises and abrasions were commonly determined but more severe injuries as accompanying trauma were less common. Severe body trauma was detected in 16 cases due to falling from height, which was secondary to electrocution. This finding was similar to a study from Bursa, Turkey (20), but significantly higher than that reported by Wick et al. from Australia (8). Traumatic lesions were more common among high-voltage related deaths compared to low voltage deaths ($P = 0.01$) (Table 5).

Klassen et al. stated that use of alcohol significantly reduces the attention of the worker (21). In this study, 23 victims (23%) tested positive for alcohol, which is much more frequent; however, blood alcohol concentration was lower than in previous studies (9). Most of the ethanol positive accidental electrocutions occurred among workers.

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Entry lesions were localized mostly on the upper limbs as detected in 74 (74%), which was parallel to a study in Gautang, South Africa (17). Similar to previous studies, in 3 cases no electric lesions were found (17,19).

Conclusion

Our study showed that occupational accidents constitute the majority of electrocution related deaths. As a developing country, in Turkey, there is acceleration in new construction sites and industries. This acceleration correlates with more occupational accidents because of lack of preventative measures for electrocution, since workers are mostly inexperienced. Because electrical injuries remain the leading cause of occupational accidents, it is important to focus on electrical injuries while examining occupational deaths for forensic investigations. Properties of the place of incident must be known to shed light on the cause and the mechanism of death, such as electrical equipment near the victim or high voltage lines nearby, especially in cases in which there are no electrical burns.

Most of the electrocutions occurring during working were considered preventable. Making sure that all the electrical devices are properly designed and maintained helps prevent electrical injuries at home and in the workplace. Educational programs for workers and employers should be provided and public and occupational safety measures should be promoted by the authorities.

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