

# Evaluation of autopsy reports in terms of preventability of traumatic deaths

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## ABSTRACT

**BACKGROUND:** The analysis of autopsy reports plays an important role in the evaluation of trauma care quality. The objective of this study was to determine the rate of preventable deaths and medical errors in regard to the autopsy reports as an indicator of trauma care quality in traumatic deaths.

**METHODS:** A retrospective review of traumatic autopsy reports kept between 2011 and 2012 in Eskişehir, Turkey was conducted. Demographic data of the cases, injury type, injury mechanism, injury location, ISS values, and cause and place of death were recorded. Deaths were judged in three groups including preventable deaths, potentially preventable deaths and non-preventable deaths. In the definition of preventability, the criteria of American College of Surgeons Committee on Trauma were used. A commission composed of two forensic medicine specialists and one emergency medicine specialist reviewed preventability and defined medical errors.

**RESULTS:** A total of five hundred and ninety-two autopsy reports were examined in the study period. Trauma was defined as the cause in 65.2% (n=386) of the cases. 81.9% (n=316) of the cases were observed to have suffered blunt injury and 18.1% (n=70) penetrating injury. Death occurred at the scene of trauma in 56.7% (n=219) of the cases, in the pre-hospital period in 11.7% (n=45), and in hospital in 31.6% (n=122). In preventability analysis, it was decided that 4.1% (n=16) of the cases had the properties of being preventable, 14.5% (n=56) potentially preventable and 81.3% (n=314) non-preventable. Suboptimal care was determined in 65.3% (n=47) of the total cases, delayed intervention in 58.3% (n=42), error in the medical method decision in 8.3% (n=6), delayed or wrong diagnosis in 1.4% (n=1), and inappropriate or incorrect medical application in 1.4% (n=1).

**CONCLUSION:** High rates of preventable deaths in the pre-hospital period, in cases of penetrating injuries, and particularly in cases of chest trauma were evaluated as noteworthy findings. Integrated working of pre-hospital emergency healthcare services with trauma centres would enable the development of trauma care and reduce the rates of preventable deaths.

**Key words:** Autopsy; medical error; preventable death; trauma.

## INTRODUCTION

Death associated with trauma is a leading cause of death in children and the young population. Morbidity and mortality rates associated with trauma have shown significant improvement in the last three-four decades due to developments in

medical science and privatised trauma care systems which have resulted in increased quality of trauma care.<sup>[1,2]</sup> Studies directed towards decreasing trauma-related deaths and increasing the quality of trauma care have concentrated on the causes of preventable deaths.

The concept of preventable death was first defined in the 1970s and stated to be cases which could survive after the application of current standard trauma care to the injuries.<sup>[3]</sup> That the rates of preventable death are related to the quality of trauma care is accepted as one of the indications. Blind clinical studies and autopsy studies have been stated as two basic methods in the determination of preventable death rates.<sup>[4]</sup> In studies directed towards the determination of trauma-related preventable deaths and increasing the quality of trauma care, autopsy studies have been reported to be effective and reliable.<sup>[5]</sup>

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This study aimed to investigate trauma care quality as an indicator of preventable death rates according to autopsy reports.

## MATERIALS AND METHODS

A retrospective review was conducted regarding the hospital records, autopsy reports and inquest files of Eskişehir Forensic Medicine Department of cases that had undergone autopsy due to trauma-related deaths between January 1, 2011 and December 31, 2012.

Cases whose cause of death was uncertain according to the autopsy and whose death was related to other causes than trauma were excluded from the study.

Demographic data, injury type, injury mechanism, injury site, Injury Severity Score (ISS) values, cause and place of death were evaluated for all cases.

Injuries were classified as blunt or penetrating. According to the site of injury, cases were classified as head, neck, chest, abdomen, pelvis, and extremities.

Systems, airway, respiratory, circulation, neurological and other reasons were classified. Place of death was classified as site of the trauma event, pre-hospital and in hospital.

Deaths were judged in three groups including preventable, potentially preventable and non-preventable. In the determination of preventability, the criteria of American College of Surgeons Committee on Trauma were used<sup>[6]</sup> (Table 1). A commission composed of two forensic medicine specialists and one emer-

gency medicine specialist reviewed preventability.

Data was evaluated using SPSS 16.0 software program and expressed as number, percentage, mean, and standard deviation values.

## RESULTS

A total of five hundred and ninety-two autopsy reports were examined in the study period. Trauma was defined as the cause of death in 65.2% (n=386) of the cases. Cause of death was determined in all cases of death due to trauma.

Three hundred and eighty-six cases comprised two hundred and ninety-two male (75.6%) and ninety-four female cases (24.4%) (M:F, 3:1). Mean age was determined 35.8±16.4 years (min 10 months, max 85 years). One hundred and twenty-five cases (32.4%) were in the 20-29 age group, and thirty-nine cases (10.1%) were aged 18 years and below (Table 2). 81.9% (n=316) of the cases were observed to have suffered blunt injury and 18.1% (n=70) penetrating injury (Fig. 1). When causes of injury were evaluated, these were determined as traffic accidents in one hundred and thirty-three cases (34.5%), stabbing in sixty-five cases (16.8%), fall from height in sixty cases (15.5%), and firearms injury in fifty-three cases (13.7%) (Fig. 2).

Excluding ninety-seven cases (25.1%) injured by drowning, stabbing and burning, the remaining two hundred and eighty-nine cases were evaluated as injuries in one anatomic area in two hundred and twenty-two cases (76.82%) and in more than one anatomic area in sixty-seven cases (23.18%). Isolated injuries were found as isolated head wound in one hun-

**Table 1.** Preventability criteria

### Preventable

Non-life-threatening injury

The injured patient is generally stable or becomes stable with treatment

There are doubts about the treatment or medical management

ISS<sup>1</sup> <20

### Potentially preventable

Very serious injury but survival is possible with optimal medical care

The injured patient is generally unstable and there is minimal response to treatment

Medical care conforms with ATLS<sup>2</sup>/PHTLS<sup>3</sup> but there are doubts about errors which may cause death directly or indirectly

ISS: 20-50

### Non-preventable

Despite optimal medical care, the injury is not compatible with survival

The physiological status in the first evaluation is not critical for the medical decision

Trauma management conforms with ATLS ve PHTLS

ISS >50

The injured patient has major comorbidities which could cause death

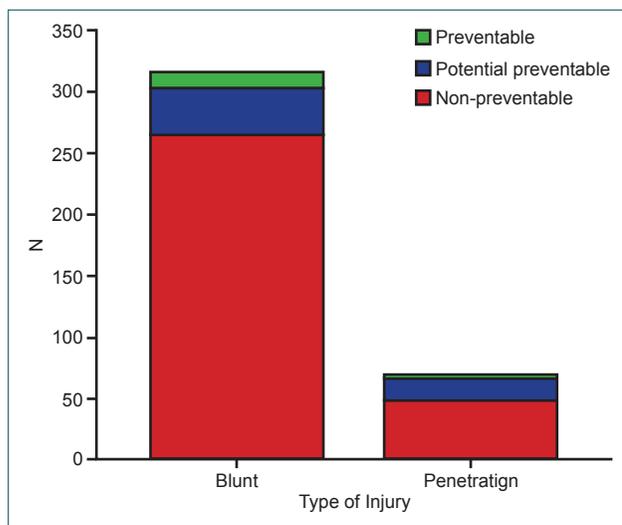
I: Injury severity score; 2: Advanced Trauma Life Support; 3: Prehospital Trauma Life Support.

**Table 2.** Case distribution by age and gender

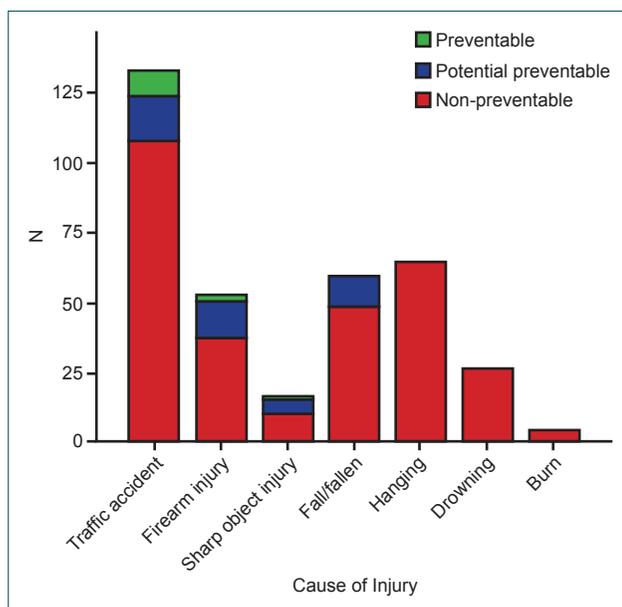
	0-9		10-19		20-29		30-39		40-49		50-59		60-69		70-79		80-85		Total	
	n	%*	n	%*	n	%*	n	%*	n	%*	n	%*	n	%*	n	%*	n	%*	n	%**
Male	7	2.4	37	12.7	75	25.7	39	13.4	64	21.9	43	14.7	19	6.5	2	0.7	6	2.1	292	75.6
Female	3	3.2	4	4.3	50	53.2	18	19.1	4	4.3	4	4.3	6	6.4	5	5.3	–	–	94	24.4
Total	10	2.6	41	10.6	125	32.4	57	14.8	68	17.6	47	12.2	25	6.5	7	1.8	6	1.6	386	100

\*Percentage of lines are used; \*\*Percentage of columns are used.

dred and thirty-eight cases (47.8%), isolated neck injury in eleven (3.8%), isolated chest injury in fifty-four (18.7%), isolated abdominal injury in eight (2.8%), and isolated extremity injury in eleven (3.8%) (Fig. 3).



**Figure 1.** Type of injury.



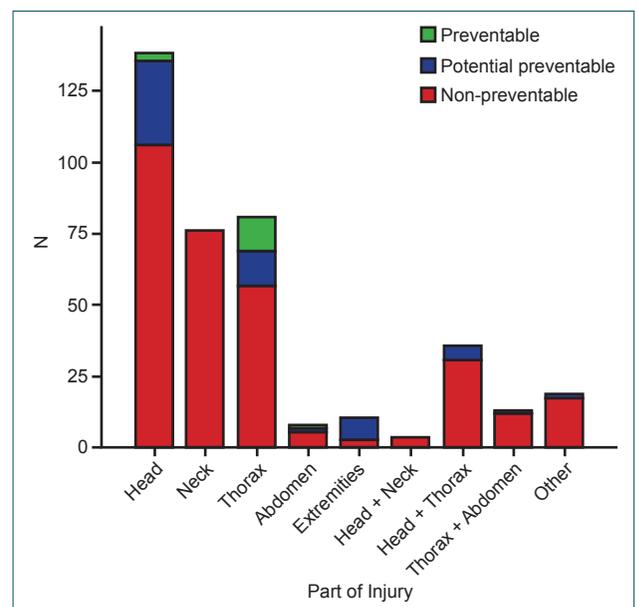
**Figure 2.** Cause of injury.

When cause of death was examined according to systems, single system impairment was determined in two hundred and thirty-two cases (60.1%), two systems in one hundred and eight (28%), and multiple systems in forty-six (11.9%). Neurological problems were determined in one hundred and forty-five cases (37.6%), isolated respiratory problems in sixty-four (16.6%), and isolated circulation problems in 6% (Table 3).

Death occurred at the scene of the trauma in two hundred and nineteen cases (56.7%), in pre-hospital period in forty-five (11.7%), and in hospital in one hundred and twenty-two (31.6%). Time of death was determined as immediate or within minutes in two hundred and twenty-eight cases (59.1%), within the first two hours in ninety-nine (25.6%), and at a later time in fifty-nine (15.3%) (Figure 4).

### Preventability

In preventability analysis, it was decided that 4.1% (n=16) of the cases had the properties of being preventable, 14.5% (n=56) of being potentially preventable and 81.3% (n=314) of being non-preventable.



**Figure 3.** Part of injury.

**Table 3.** Distribution of cause of death according to affected systems

Single system	Two systems		Multiple systems		
A	–	A+B	66	B+C+D	40
B	64	B+C	39	B+C+D	6
C	23	D+E	3		
D	145				
E	–				
Total	232		108		46

Mean ISS scores of the cases determined as preventable, potentially preventable and non-preventable were calculated as  $15.8 \pm 4.2$ ,  $33.6 \pm 9.3$  and  $55.1 \pm 13.7$ , respectively.

### Causes of Preventable Deaths

Sixteen cases evaluated as preventable deaths comprised 10 male and 6 female cases (M:F, 1.7:1) with a mean age of  $30.4 \pm 9.3$  years. The injuries were blunt in thirteen cases (81.3%) and penetrating in three (17.8%).

The mechanism of trauma was traffic accident in nine cases (56.2%), blunt trauma in four (25%), firearms in two (12.5%) and sharp penetrative tool in one (6.2%).

Isolated respiratory problems were determined in eleven cases (68.8%), isolated circulation problems in one case (6.2%), isolated neurological problems in one case (6.2%), and respiratory and circulation problems in three cases (18.8%).

Death occurred at the scene of the trauma in four cases (25%), in the pre-hospital period in seven (43.8%), and in the hospital in five (31.2%).

### Causes of Potentially Preventable Deaths

Fifty-six cases evaluated as potentially preventable deaths comprised male and female cases at a ratio of 1.7:1, with a mean age of  $36.1 \pm 14.5$  years. The injuries were blunt in thirty-eight cases (67.9%) and penetrating in eighteen (32.1%).

The mechanism of trauma was traffic accident in sixteen cases (28.6%), firearms in thirteen (23.2%), blunt trauma in eleven (19.6%), fall from height in eleven (19.6%), and sharp penetrative tool in five (8.8%).

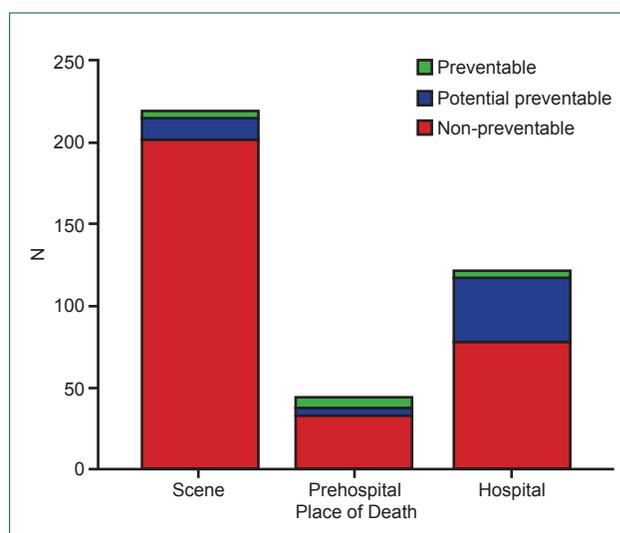
Isolated respiratory problems were determined in twenty-seven cases (48.2%), isolated circulation problems in nine cases (16.1%), isolated neurological problems in eleven cases (19.6%), two systems were affected in three cases (5.4%) and multiple systems in five cases (8.8%).

Death occurred at the scene of the trauma in thirteen cases

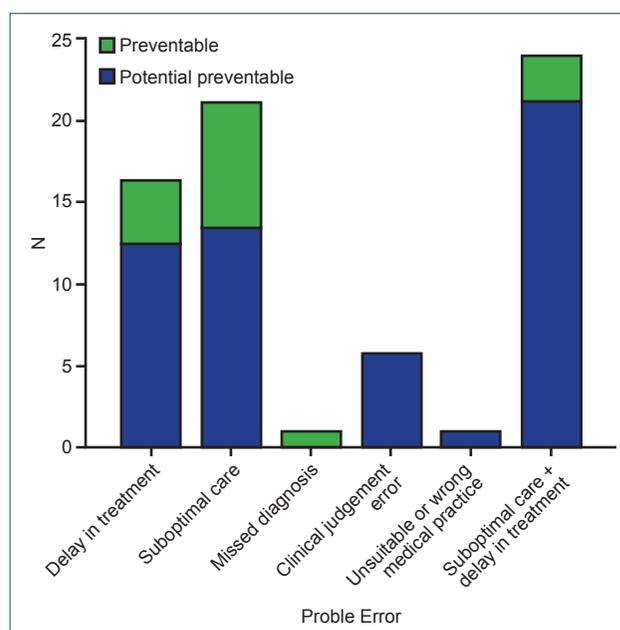
(23.2%), in the pre-hospital period in four (7.1%) and in the hospital in thirty-nine (69.7%).

### Medical Errors

When medical errors were evaluated in seventy-two preventable and potentially preventable deaths, a single error was determined in forty-seven cases (65.3%) and two errors in twenty-five cases (34.7%). Evaluation was performed on a total of ninety-seven errors which were detected from seventy-two cases in our study. Suboptimal care was determined in forty-seven (65.3%) of the total cases, delayed intervention in forty-two (58.3%), error in the medical method decision in six (8.3%), delayed or wrong diagnosis in one (1.4%), and inappropriate or incorrect medical application in one (1.4%) (Figure 5).



**Figure 4.** Distribution of cases according to preventability and place of death.



**Figure 5.** Probable error.

## DISCUSSION

Trauma is a leading cause of mortality particularly affecting the young population. Therefore, evaluation of preventability in traumatic deaths is critically important for improving the quality of trauma care and reducing medical errors. Studies in the literature analyzing traumatic deaths can generally be categorised as studies which have only used data of the cases that reached the hospital and those which included pre-hospital data. The studies which include pre-hospital data are more general but are evaluated as including more sound epidemiological data. Although the analyses of cases reaching the hospital lack a portion of traumatic deaths, they seem to have reached clearer results with more detailed and appropriate data collected. In a 2008 study of traumatic deaths by Durusu et al.,<sup>[7]</sup> limitation was reported to be lack of pre-hospital data due to inadequate records and documentation.

When the demographic characteristics of traumatic death cases are examined in the literature, different data is seen to have reported the mean age between 35 and 55 years. In developed countries, the elderly population has been reported to be affected by traumatic death, but generally, studies have reported a greater distribution in the 3<sup>rd</sup> decade and of male gender. Mean age in our study was  $35.8 \pm 16.4$ . The average value is compatible with the studies conducted at national level, but not with the foreign studies where the average value is lower.

*Causes of injury:* Four most common causes of injury were traffic accidents, firearms injuries, falls from height and sharp penetrative tools, and these were seen in this order at similar ratios in preventable and non-preventable deaths. These findings were compatible with the studies in the literature. In a study by Ohene et al.<sup>[8]</sup> evaluating adolescent traumatic deaths, findings have been different with the most common cause being drowning (37%) then traffic accidents (33%). This difference can be considered to be due to the age group or regional differences. In a study by Sharma et al.,<sup>[9]</sup> in which diagnostic errors have been evaluated in cases reaching the hospital, head trauma has been reported to be the most common at a rate of 56%. In the current study, head trauma was again in first place at a rate of 50%. It was also reported first place at a rate of 38% in the study by Durusu et al.<sup>[7]</sup> However, it is noticeable that the rates of preventability in these cases were extremely low compared to other anatomic areas.

*Distribution according to place and time of death:* In a retrospective study by Sanddal et al.<sup>[10]</sup> investigating the causes of preventable death in cases which reached the hospital, deaths have been reported to have occurred in the first 24 hours in 84% of cases and after 24 hours in the remaining 16%. De Knecht et al.<sup>[11]</sup> have also reviewed time of death in cases which reached the hospital and reported time of death to be in the first hour in 11.5% and in the first 24 hours in 47% of the cases.

In these two studies, rates of death in the first hour and in the early period are lower than the findings of the current study, which is thought to be due to the exclusion of cases where death was recorded at the site of trauma or in pre-hospital period. In a study by Evans et al.<sup>[12]</sup> of one hundred and seventy-five cases including pre-hospital deaths, the rate of pre-hospital deaths has been reported at approximately 65%, which is compatible with the findings of the current study. In a 2003 study in South Africa by Meel et al.<sup>[13]</sup> evaluating traumatic deaths, pre-hospital deaths were reported at 74%. The higher rates of these studies than those of the current study are thought to be related with the inadequacy of the pre-hospital emergency services.

The study by Durusu et al.<sup>[7]</sup> reported that deaths occurred at the site of the incident in 52.46% of the cases, in the pre-hospital period in 6.92%, and in hospital in 40.61%. Although these findings are similar to those of the current study, the rates at the site of the incident and in the pre-hospital period are seen to be lower and deaths in hospital are proportionally higher. This difference is thought to be due to regional differences and a higher proportion of cases of burns, drowning and stabbings than in the current study.

*Preventability:* When preventability rates of traumatic deaths are examined, various rates between 2% and 20% have been reported. In a review of twenty-four studies by Settervall et al.,<sup>[14]</sup> mean preventability rate has been reported as 10.7%. In a study by Kleber et al.<sup>[15]</sup> of two hundred and sixty-four traumatic deaths, the reported rates have been 5.3% preventable, 9.9% potentially preventable, and 84.8% non-preventable. Saltzherr et al.<sup>[16]</sup> have evaluated forty-four cases of traumatic death in a Level I trauma centre and stated that one case was preventable and five cases were potentially preventable. Hogan et al.<sup>[17]</sup> have randomly selected two hundred and fifty cases of traumatic death from hospital records and the preventability rate was found to be 5.2%. In the examination of previous studies, inclusion of pre-hospital deaths, older studies and studies conducted in a region without a trauma centre were observed to be factors raising preventability rates.

In an autopsy study by Wilson et al.<sup>[18]</sup> in which a series of five hundred traumatic deaths have been analysed, the preventability rate is reported 14%. This rate is relatively high due to not using the category of potentially preventable.

In 2008, Durusu et al.<sup>[7]</sup> evaluated seven hundred forty-seven traumatic deaths and reported a preventable death rate at 4.15%, potentially preventable death at 16.2% and non-preventable at 79.65%. Although four years have passed since that study, similar rates are seen at national level.

When the connection of preventability rates with other variables is examined, pre-hospital preventable deaths are seen to be proportionally high, and there is an excessive rate of

potentially preventable deaths in the hospital. Although there is a great number of deaths at the site of the trauma, the majority are non-preventable. In addition, despite head trauma being the leading cause of deaths associated with trauma, the majority have the properties of non-preventable deaths, and the proportionally high rates of chest trauma, particularly as preventable and potentially preventable deaths, are evaluated as significant.

**Medical Errors:** Single error per case in forty-seven cases and double error per case in twenty-five cases, totally 97 errors, were detected from preventable and potentially preventable deaths in the group of patients who had a total of seventy-two cases. Suboptimal care in 65.3% of the patients (n=47) and interference delay in 58.3% (n=42) of the patients were the most frequently detected medical errors. The least common errors were delayed or incorrect diagnosis in 1.4% (n=1) of the patients and inappropriate or incorrect medical malpractice in 1.4% (n=1) of the patients. When the literature was reviewed for medical errors related to traumatic deaths, it was seen that medical errors were categorised in different ways. In a study by Ivatury et al.<sup>[19]</sup> evaluating seven hundred and sixty-four cases of traumatic deaths, medical errors have been reported at a rate of 9.9%. Zafarghandi et al.<sup>[20]</sup> have evaluated one hundred and sixty-five traumatic deaths in Tehran and classified the cases as with and without central nervous system involvement, and medical errors have been categorised as diagnostic errors and treatment errors. A total of sixty-four medical errors have been determined as fifteen diagnostic errors in fifteen cases and forty-nine treatment errors in twenty-five cases. Vast majority of the errors were in injuries not related to the central nervous system and were treatment errors. As diagnostic errors were relatively fewer, this can be accepted as conforming the findings of the current study.

In a study by Teixeira et al.<sup>[21]</sup> evaluating two thousand and eighty-nine traumatic deaths that reached hospital, medical errors have been categorised as delay in treatment, clinical judgement error, missed diagnosis, technical error, and other errors. Delay in treatment and clinical judgement error have been reported as the most frequently made errors. As suboptimal care has not been categorised, the findings of that study conform those of the current study.

In a 2008 study by Durusu et al.<sup>[7]</sup> evaluating seven hundred and forty-seven traumatic deaths, medical errors were reported as delay in treatment at 49.34% and suboptimal care at 41.5%. Although the order is similar, these findings are seen to be at a higher rate than those of the current study. This result is thought to be possibly due to regional differences or differences related to evaluation.

**ISS Scores:** Ince et al.<sup>[22]</sup> have declared that patient deaths are considered to be preventable with an ISS score  $\leq 14$  in their study including one hundred and sixty posttraumatic

deaths comparing ISS on admission to trauma center with the ISS during autopsy. Although clinical evaluation has revealed preventability rate of death as 12%, post autopsy evaluation has revealed a rate of 3%. In our study, evaluation was made only upon autopsy; Ince et al. has reported minimally lower preventability rates when compared with our rates. The difference is considered to be due to determining the upper limit of ISS as 20 in terms of preventability in our study.

## Limitations

In the current study, all data and preventability decisions were conducted on autopsy reports and additional patient files. As there was a low number of cases in some sub-groups like isolated abdominal injury, the power of preventability rates of those groups was evaluated as having decreased. In the analysis of medical errors, objective criteria were not used and evaluation was made by a specialist physician and recorded. Records of deaths at the site of trauma and in the pre-hospital period were seen to be more limited, and thus, preventability and medical error decisions were made on the basis of fewer data.

ISS of patients during admission to emergency service could not be calculated while ISS was calculated according to the autopsy data of the study. ISS acquired from autopsy might be different from those which were obtained from first evaluation during admission to the emergency service. Ince et al.<sup>[22]</sup> reported that ISS scores obtained from autopsy might be different from the ISS obtained from clinical evaluation in their study based on trauma scoring systems conducted in 2006.

## Conclusion

When the findings of the current study were evaluated together with those of the literature, preventability rates were seen to be lower in regions where there were efficiently working trauma centres. It was noticeable that the rates of preventable death were found to be higher in the pre-hospital period, in cases of penetrating injury, and particularly in cases of chest trauma. The integration of pre-hospital emergency healthcare services with trauma centres would enable trauma care to be developed and reduce the rates of preventable deaths.

Conflict of interest: None declared.

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## KLİNİK ÇALIŞMA - ÖZET

### Travmatik ölümlerde otopsi raporlarının önenebilirlik açısından değerlendirilmesi

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**AMAÇ:** Bu çalışmada travmatik ölümlerde, travma bakım kalitesinin bir göstergesi olarak önenebilir ölüm oranlarının ve medikal hataların otopsi raporlarına göre araştırılması amaçlandı.

**GEREÇ VE YÖNTEM:** Eskişehir/Türkiye'de 2011 ve 2012 yıllarına ait travmatik otopsi raporları geriye dönük olarak incelendi. Olguların demografik verileri, yaralanma tipi, yaralanma nedeni, yaralanma bölgesi, ISS değerleri, ölüm nedeni ve ölüm yeri kaydedildi. Bütün ölümler önenebilir, potansiyel önenebilir ve önenebilir olmayan ölüm olmak üzere üç gruba ayrıldı.

**BULGULAR:** Çalışma döneminde 386 travmatik otopsi raporu incelendi. Olguların %81.9'unun (n=316) künt, %18.1'inin (n=70) ise penetran yaralanmaya maruz kaldığı gözlemlendi. Yine olguların %56.7'sinin (n=219) olay yerinde, %11.7'sinin hastane öncesinde (n=45), %31.6'sının (n=122) hastanede öldüğü belirlenmiştir. Önenebilirlik analizinde olguların %4.1'inin önenebilir (n=16), %14.5'inin (n=56) potansiyel önenebilir ve %81.3'ünün (n=314) önenebilir nitelikte olduğuna karar verildi. Toplamda olguların %65.3'ünde (n=47) suboptimal bakım, %58.3'ünde (n=42) müdahalenin gecikmesi hataları gözlemlendi.

**TARTIŞMA:** Önenebilir ölüm oranlarının hastane öncesi periyotta, penetran yaralanmalarda ve özellikle göğüs travmalarında yüksek bulunmasının dikkat çekici bulgular olduğu değerlendirilmektedir.

**Anahtar sözcükler:** Medikal hata; otopsi; önenebilir ölüm; travma.

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