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ORIGINAL ARTICLE

Assessment of helicopter versus ground emergency medical services in reducing mortality rate and the length of stay in adult trauma patients between 2002 and 2014 recorded in King Abdulaziz Medical City trauma registry

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ABSTRACT

Background: Trauma is the third leading cause of death worldwide and the most common cause of death among people aged 1–44 years. In Saudi Arabia, traumatic injuries cause one death and four injuries every hour, but survival rates have improved owing to improvements in pre-hospital care processes.

Methodology: This retrospective study conducted in King Abdulaziz Medical City (KAMC), Emergency Medicine Department, included data taken from KAMC trauma registry, QuadraMed®, and patients' files. Injury Severity Score (ISS) was used to assess the severity of trauma. We included individuals of both sexes with ISS of ≥9 and aged ≥15 years with different types and mechanisms of injury.

Results: Overall, 335 patients (123 transported by helicopter and 212 transported by ground ambulance) were included. The mean ISS for helicopter emergency medical services (HEMS) and ground emergency medical services (GEMS) patients was 20.80 and 19.74, respectively. All HEMS patients had blunt trauma. For GEMS patients, 94.8% had blunt trauma and 5.2% penetrating trauma. Around 81.1% of GEMS patients went home and 18.9% died in hospital. For HEMS patients, 79.7% went home, 14.6% died, and 5.7% were transferred to other hospitals. The mean of length stay among HEMS patients was 46.18 days, whereas it was 44.59 days among GEMS patients.

Conclusion: This study suggests that HEMS is associated with a higher survival rate for severe trauma patients than GEMS. However, HEMS patients had a longer length of stay in hospital than GEMS patients.

Keywords: Emergency medical services, pre-hospital, trauma, helicopter, ambulance.

Introduction

Trauma is the third leading cause of death worldwide and the most common cause of death among individuals aged 1–44 years [1]. Nearly, 16,000 people die every day, and about 5.8 million people die from trauma every year [2]. Trauma refers to a physical injury, which is caused by blunt, penetrating, or burn mechanism, leading to a higher risk of functional impairment or death [2]. In Saudi Arabia, it has been estimated that traumatic injuries cause one death and four injuries every hour [2].

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According to a local study, in 2014 at a tertiary health care hospital in Riyadh, by Alghnam et al. [3], it was shown that road traffic and falls were the most common causes of trauma with percentages of 52% and 25.6%, respectively. Regardless, significant improvements in survival rate after trauma have been achieved due to improvements in pre-hospital care processes [4]

Several studies have been conducted to compare helicopter emergency medical services (HEMS) and ground emergency medical services (GEMS) in order to assess outcomes to improve medical services provided to patients with severe trauma. In the United States, it was found that patients with blunt trauma transported via HEMS had higher chances of surviving than those transported by GEMS [5]. Similarly, a study conducted in Georgia, US, showed that patients transported by HEMS, who had worse injuries than those carried by other means, were found to have a higher survival rate [6]. However, in Saudi Arabia, no study has compared the outcomes among traumatically injured adults transport by either HEMS or GEMS.

The aim of this study was to compare the mortality rate and the length of stay in adult trauma patients in King Abdulaziz Medical City (KAMC) trauma registry in Riyadh transported via the HEMS and GEMS.

Subjects and Methods

The study was conducted in KAMC, Department of Emergency Medicine, Riyadh, Saudi Arabia. KAMC is a tertiary care center, in which the Emergency Department has several divisions including the Resuscitation Unit, Acute Care Unit, Rapid Assessment Management Unit (RAM), Clinical Decision Unit (CDU), Emergency Medical Services (EMS), Clinical Toxicology, Flu Clinic, and Drive Through Screening unit (DTS) [7].

For the purpose of this research, a retrospective cohort study was chosen in order to establish the relation between the method of transportation, i.e., HEMS or GEMS, and the patients' outcomes in the period of 2002–2014.

The data were taken from the Ministry of National Guard Health Affairs (MNGHA), KAMC trauma registry, QuadraMed® system, and patients' files.

The Injury Severity Score (ISS) was used to assess the severity of trauma. The ISS is a. scale from 1 to 75, which measures the injury severity in a traumatic patient based on body regions. ISS greater than or equal to 9 was included as the minimum ISS transported by helicopter is 9.

We include both males and females and all individuals 15 years old or older which is the adulthood age in Saudi Arabia. In addition, the mechanism of injury was captured, which included whether it was blunt or penetrating trauma. Burns, bites, stings, drowning, and suffocation were excluded. Patients transferred by GEMS or HEMS were included. However, patients transferred by private conveyance and police and walk-ins were excluded, as well as patients who died before the arrival to the emergency department. Moreover, any patient who had missing data was also excluded.

The population size was equal to 2,523 patients between the period of 2002 and 2014 and the recommended sample size was 335 as determined by using Raosoft®. Randomization was performed by taking the sixth patient with a confidence interval of 95% and a 5% margin of error.

Variables that were collected included vital signs (heart rate, respiratory rate, and systolic blood pressure) first recorded in the emergency department. In addition, the Glasgow Coma Scale was included, as well as patient disposition, patient discharge, or death.

Descriptive statistics such as percentages, mean, median, interquartile range, and standard deviation were used. Analytical statistics were applied to test the association between the patients' transported method and hospital covariates or patients' characteristics. Pearson chi-squared test and Fisher exact test were used for categorical data, and independent samples *t*-test and Mann–Whitney test were used for numerical data. The data collected were analyzed using the Statistical Package for the Social Sciences, Version 20.0 (IBM Corporation, Armonk, NY, USA). A *p*-value less than 0.05 was considered as statistically significant.

Results

The total number of patients was 335 patients, taken from MNGHA, KAMC trauma registry from 2002 to 2014. All subjects were aged ≥15 years. Both genders were included, and the ISS was 9 and above. Data are summarized in Tables 1–4. In total, 123 patients were transported by helicopter and 212 patients by ground ambulance.

Most of the patients were males (91.6%, 307/335), and 192 were transported by ground ambulance, whereas 115 were transported by helicopter. Females constituted 8.4% (28/335) of patients, and 20 were transported by ground, whereas only 8 were transported by helicopter. In addition, most of the traumatic patients were aged between 15 and 34 years (221 patients, 66%) ($p = 0.025$). From this age group, 140 patients (66%) were transported by ground ambulance, whereas 81 (65.9%) were transported by helicopter ($p = 0.025$).

The mean ISS for the helicopter-transported and ground-transported patients was 20.80 and 19.74, respectively. Furthermore, concerning the type of trauma, 324 patients had blunt trauma. All of the helicopter-transported patients had blunt trauma, whereas 94.8% of the ambulance-transported patients had blunt trauma, and 5.2% had penetrating trauma ($p = 0.009$). The most common mechanism of injury was motor vehicle accident (MVA) and motorcycle accounted for 81.2%. Of all patients, 95.9% transported by helicopter had MVA or motorcycle accidents compared to 72.6% among patients transported by ground ambulance ($p < 0.001$).

Table 1. *Characteristics of patients transported by emergency medical services to trauma center.*

Characteristics		Total *N*=335 *N*(%)	Helicopter *N*=123 *N*(%)	Ground *N*=212 *N*(%)	Statistical significance
Sex	Male	307(91.6)	115(93.5)	192(90.6)	x^2=0.87; *p*=0.350
	Female	28(8.4)	8(6.5)	20(9.4)	
Age, years	15–34	221(66)	81(65.9)	140(66)	x^2=7.4; *p*=0.025*
	35–54	87(26)	38(30.9)	49(23.1)	
	>55	27(8.1)	4(3.3)	23(10.8)	
ISS	9–20	190(56.9)	64(19.2)	126(37.7)	x^2=1.8; *p*=0.391
	20–40	126(37.7)	52(15.6)	74(22.2)	
	>40	19(5.7)	7(2.1)	12(3)	
Injury type	Blunt	324(96.7)	123(100)	201(94.8)	x^2=6.5; *p*=0.009*
	penetrating	11(3.3)	0	11(5.2)	
Mechanism of injury	Fall	13(3.9)	1(0.8)	12(5.7)	x^2=27.7; *p*<0.001*
	MVA and Motorcycle	272(81.2)	118(95.9)	154(72.6)	
	Pedestrian	32.(9.6)	2(1.6)	30(14.2)	
	Other	13(3.9)	2(1.6)	16(7.5)	

*Statistically significant; ISS, injury severity score; MVA, motor vehicle accident.

Table 2. *Characteristics of patients transported by emergency medical services trauma center by mean (SD).*

Characteristics	Total *N*=335	Helicopter *N*=123	Ground *N*=212	Statistical significance
Length of stay, days Median (IQR)	45.18(76.6)	46.18(64.4)	44.59(83.1)	*p*=0.018⊥*
	18(36)	23(35)	15(37)	
Heart rate, beat/min	105.16(25.8)	109.10(24.9)	102.87(26.1)	*p*=0.033*
Respiratory rate, breath/min	23.(6.9)	22.95(6.4)	23.05(7.3)	*p*=0.899
Blood pressure, systolic	134.8(55.9)	136.83(83)	133.64(30.7)	*p*=0.616
GCS	9.90(5.1)	9.33(5.4)	10.24(4.9)	*p*=0.122
ISS	20.10(11.1)	20.80.(9.9)	19.74(11.7)	*p*=0.396

⊥Mann-Whitney test was applied,*Statistically significant; GCS, Glasgow coma scale; ISS: injury severity score.

Table 3. *Association between transportation method and outcome among patients.*

Outcome		Total *N*=335 *N*(%)	Helicopter *N*=123 *N*(%)	Ground *N*=212 *N*(%)	Statistical significance
Discharged from	Ward	276 (82.4)	105(85.4)	172(80.7)	x^2=4.5; *p*=0.332
	ICU	38(11.3)	13(10.6)	25(11.8)	
	OR	7(2.1)	1(0.8)	6(2.8)	
	ER	13(3.9)	3(2.4)	10(4.7)	
	CCU	1(0.3)	1(0.8)	0	
Disposition to	Home	270(80.6)	98(79.7)	172(81.1)	x^2=12.8; 0.002*
	Death	58(17.3)	18(14.6)	40(18.9)	
	Transferred	7(2.1)	7(5.7)	0	

*Statistically significant; ICU, intensive care unit; OR, operation room; ER, emergency room; CCU, coronary care unit.

Furthermore, the total percentage of deaths was 17.3% most of which were among patients transported by ground ambulance. In addition, 38 patients, who were admitted, died in the intensive care unit, 25 of whom were transported by ground ambulance. Similarly, the majority (5 out of 6) of patients who died in the operating room were transported by ground. Regarding ground ambulance transportation, 81.1% of patients were discharged home and 18.9% died in the hospital, whereas for helicopter transportation, 79.7% were discharged home, 14.6% died, and 5.7% were transferred to other hospitals (p = 0.002). In addition, regarding the mean length of stay, for those transported by helicopter it was 46.18 days, whereas the mean length of stay was 44.59 days for patients who were transported by ground ambulance (p = 0.018). The last variable considered was patients' vitals, and patients transported by helicopter had a significantly higher heart rate than those transported by ground ambulance (p = 0.033).

Table 4. *Number of disposed patients according to discharge.*

Discharged from	Disposition to			
	Home	Death	Transferred	Total
Ward	269	0	7	276
ICU	0	38	0	38
OR	1	6	0	7
ER	0	13	0	13
CCU	0	1	0	1
Total	270	58	7	335

ICU, intensive care unit; OR, operation room; ER, emergency room; CCU, corcnary care unit

Discussion

Many studies have assessed the differences between HEMS and GEMS, which helped improve medical services provided to patients with severe trauma. The etiology behind trauma as observed in our results was similar to that reported in other studies. Blunt trauma was more common than penetrating trauma (96.7% vs 3.3%) and the most common causes were MVA and motorcycle accident (81.2 %). Alghnam et al. [3] reported similar results that the prevalence of traffic accident was 52% of the total causes of trauma, which also matched the previous Ministry of Health published statistics [3]. Similarly, Hokkam et al. [2] showed blunt trauma to be the most common type of injury, and a road traffic accident was the most common cause.

Gender differences in outcome have also been observed in some studies. For example, Thibaut et al. [8] suggested that males were at a higher risk of death. Moreover, most of the patients in this study were males (91.6%). The prevalence of trauma in specific age groups was also assessed in our study. About 66% of all patients were aged between 15 and 35 years. Similarly, a study done in Jazan general hospital showed that most of their patients were young (18–30 years old, accounting for 45.1% of all patients) [2].

Moreover, Toshikazu et al. [7] found that among patients with major trauma in Japan, transport by helicopter with a physician may be associated with improved survival to hospital discharge compared to ground emergency services after controlling for several known confounders. They concluded that 26.1% of the patients transported by helicopter died compared to 26.0% of the patient carried by ground emergency services. However, the results of our study showed that GEMS is associated with increased mortality compared to HEMS with similar other variables. In our study, the mortality rate associated with GEMS was 68.96%. In contrast, the mortality rate associated with HEMS was 31.03%. GEMS was associated with a shorter hospital stay regardless of the similar vital signs and Glasgow coma scale for both modalities. Patients who were transferred by ground ambulance stayed 44.59 days, overall. In contrast, patients who were transported by helicopter stayed 46.18 days in the hospital.

This study has several limitations. First, we had limited data about HEMS, and some were missing because this transportation method is underused. However, regarding GEMS, there was a significant amount of data; thus, we only used the required amount of data to meet the sample size. Second, there was a lack of data regarding the distance and time of transportation from the scene to the hospital. Nevertheless, we found that HEMS can transport patients with severe injuries, especially at greater distances, significantly faster than GEMS. Moreover, time to definitive trauma care is known to robustly affect the outcomes [7]. Third, we did not have enough data concerning the presence of physicians in the said vehicles, and the roles they played in the outcomes. Indeed, this difference is one of the most important factors affecting survival [7]. Fourth, because helicopter transportation is one of the most expensive interventions in present-day health care, the cost must be considered. However, the price of each vehicle was not available for our study. Fifth, there could be a bias, considering females in Kingdom of Saudi Arabia (KSA) were not allowed to drive at the time of the study. For this reason, the data and results were dominated by male samples. Lastly, this is a retrospective study, which is a limitation by itself.

Although the result of this study suggested that HEMS transport is associated with improved survival of injured adults compared to ground services, further research is needed to decide whether helicopter transportation alone is the main contributing factor to survival outcome or there was a role for transportation time, distance from the scene, and the high-level care such as trained physicians and advanced paramedics in the outcome.

The results of this study can be applied if similar setting and participants are present. Further researches are needed in this area to support the results.

Conclusion

This study suggests that HEMS is associated with a higher survival rate among patients with severe trauma compared to GEMS. However, patients who were transported by helicopter had a longer length of stay in the hospital than those who were transported by ground ambulance. Furthermore, patients transported by helicopter had a higher heart rate than those transported by ground ambulance. Additional research is needed to determine how transportation by helicopter or fully equipped pre-hospital management could be correlated with the improvement of survival rate.

List of Abbreviations

GEMS Ground emergency medical services
HEMS Helicopter emergency medical services
ISS Injury Severity Score
KAMC King Abdulaziz Medical City
MNGHA Ministry of National Guard Health Affairs
MVA Motor vehicle accident

Conflict of Interest

The authors declare that they have no competing interests.

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Consent for publication
Informed consent was obtained from all participants included in the study.

Ethical approval
The study was entirely based on register data and was approved by the King Abdullah International Research Center (IRBC/1044/16).
Ethics approval was sought from the Institutional Review board via ref SP16/259.

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