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Evaluating The Role Of Air Ambulance Transport And Medical Evacuation In Saving Critical Cases

Sultan Mohammed Alqahtani[1], Thamer Saeed Alshehri[2], Osama Saleh Alzahrani[3], Naif Saeed Dughrush[4], Sultan Haif Alahmari[5], Ahmed Hamed Ali Saigh[6], Nawaf Honbos Alqahtani[7], Basil Saleh A Alqahtani[8], Khalid Abdullah Alqarni[9], Khalid Jamaan Alzahrani[10], Nouraddin Yahya Moafa[11]

[1-11]Emergency Medical Specialist - Armed forces hospital in southern region.

ABSTRACT

The geographical limits of Saudi Arabia are a serious impediment to the quick delivery of emergency services to patients with acute illness, but a structured, quantitative evaluation of how its service of air ambulance service changes the survival of patients could not be located. Hence, the current research was conducted to determine whether air ambulance transportation is associated with a survival benefit for critical cases compared to ground transportation, in terms of injury severity. The retrospective cohort study was conducted, relying on the data of 600 patients (300 in each cohort) transported in the period between 2020 and 2023. The multivariate logistic regression was used to assess the in-hospital mortality, which is adjusted by the Injury Severity Score (ISS), Glasgow Coma Scale (GCS), and age. The unadjusted mortality rate was more frequent in the air cohort (30.0 0 1 vs. 15.0 0 1, 0 = 2027, p 0 001), as they were more acute. After adjustment, however, there was an independent negative relationship between air transport and a 48 per cent decrease in the odds of dying (Adjusted Odds Ratio = -0.52, 95 per cent CI = -0.31-0.85, p = 0.009). Kaplan-Meier analysis also supported a significantly higher 30-day survival rate of the air cohort (72.1%, 58.5%, log-rank p = < 0.001). This research provides solid information that emergency flights in Saudi Arabia are highly effective in saving the lives of severely ill and injured individuals and can, therefore, be an important part of the national emergency care infrastructure. The results highlight the importance of en-route care to mitigate the threat of long transportation periods in geographically dispersed areas.

Keywords: Aeromedical, Critical Care, Medical Evacuation, Pre-hospital, Trauma Outcomes.

1. INTRODUCTION

The delivery of modern and prompt medical services to the critically ill or injured patients in geographically dispersed areas is one of the most significant burdens on modern health care systems [1]. Air ambulance services and medical evacuation (medevac) systems are thus an essential element of the emergency response system [2], in such situations, to fill the long distances and provide specialized care during transit [3]. The Kingdom of Saudi Arabia, with its vast landmass, consisting of inaccessible desert routes and sparsely populated regions, is a unique and interesting context to assess the effectiveness of these services [4]. The country has also greatly invested in its healthcare system to include an advanced aeromedical network, but a stringent data-driven evaluation of its effect on patient outcomes of critical cases has been conspicuously lacking in the scientific literature [5,6]. This paper has thus attempted to determine the importance of air ambulance transportation and medical evacuation to rescuing critical cases in the Saudi Arabian context [7].

The evidence on the efficacy of Helicopter Emergency Medical Services (HEMS) is also substantial in the international community, but the research tends to be characterized by issues of methodology [8]. The systematic reviews and meta-analyses have often shown that the survival of trauma patients transported by air is better than that of those transported by other means, even with the severity of injury taken into consideration [9]. This advantage has been greatly credited to the crew factor, the availability of highly trained physicians, flight nurses, or highly trained paramedics who can give complex pre-hospital interventions [10] like advanced airway management, blood product transfusion, and resuscitative surgery. Moreover, the rotor-wing aircraft speed is assumed to lower the period to definitive care within a trauma centre, and this principle was historically condensed into the so-called golden hour [11]. Nonetheless, this international agreement is not unanimous, and some of the studies doubt that HEMS is cost-effective and that the inherent selection bias whereby the most devastated patients are given air transport may distort outcome comparisons [12]. This global discussion explains why context-based analyses are crucial since the functionality of such systems depends greatly on the local geography, dispatch procedures, and hospital capacity [13].

The aeromedical outcome literature in Saudi Arabia is infantile. The previous publications have been mainly reliant on the description of the operational structure, case volumes, and logistical frameworks of the service [14]. Although such studies offer a significant baseline of the ability of the system, they do not go any further in attempting to quantitatively identify the relationship between the service and clinical outcomes like mortality and morbidity [15]. There is a major knowledge gap in the realization of whether the theoretical benefits of air medical transport, which have been witnessed in other systems, can be translated to the practical benefits of saving the critically ill patients of the Kingdom [16]. This is an important gap in light of the unique environmental problems facing the country, and its current attempts to streamline a comprehensive emergency medical service (EMS) plan [17]. In the absence of strong local evidence, healthcare policy makers and EMS executives must be content to work with international data, which might not accurately represent the realities of the operations and patient demographics of the area [18].

This is a major gap in evidence that led to this research. The research was motivated by the fact that it was necessary to go beyond descriptions and offer a rigorous and analytical evaluation of the performance of the Saudi aeromedical system [19]. The lack of empirical evidence that quantifies the clinical outcomes of air ambulance services on patient outcomes of critical cases in the Kingdom was the main research problem [20]. To conduct a systematic study of this issue, three main objectives were used to guide the study, each of them was directly related to the methodology: first, to compare the critical patients transported by air ambulances with the critical patients transported by ground emergency medical services in terms of key patient outcome measures, namely the mortality rates, with the help of both univariate and multivariate statistical analyses being used to control potential confounding effects; second, to analyse the effect of the specific transport-related factors, i.e., pre-hospital care interventions and response times [21].

To address these aims, a retrospective cohort study was planned, which involved the analysis of 600 critical care patients. The methodology was designed to address the problem of confounding by indication directly by using a multivariate logistic regression model, which adjusted for the most important variables, including Injury Severity Score (ISS), Glasgow Coma Scale (GCS), and age. This was chosen as an analytical method to maximize the independent effect of the selected modality of transport on the patient as opposed to the deeper differences that do exist in patient acuity between air and ground cohorts. This study offers a holistic picture of the effectiveness of the system both clinically and operationally by comparing the two groups not only on mortality but also on such operational parameters as total response time and length of stay in the intensive care unit. The subsequent parts elaborate on the results of this research and provide a reflection on its implications for pre-hospital care across Saudi Arabia, and add an important regional insight to the world of aeromedical excellence.

2. METHODOLOGY

1. Research Problem & Site

The research problem filled the gap existing on empirical evidence in quantifying the clinical and operational efficacy of air ambulance services on patient outcomes in critical cases in the Kingdom of Saudi Arabia. The research was carried out in the Kingdom of Saudi Arabia, one of the areas where large deserts and isolated communities exist, and emergency medical assistance poses special logistical problems. The retrospective data were obtained in major tertiary care hospitals and the operational logs of the air ambulance division of the Saudi Red Crescent Authority.

2. Research Design

Type of Study: A retrospective cohort study and a correlational/comparative design were used.

Design Justification: This design has been chosen as the most suitable due to a number of reasons. One is, it was retrospective and therefore enabled the examination of the available data on a sufficient number of critical cases, which would be ethically and logistically difficult to study prospectively. Second, the cohort design allowed the researcher to compare two naturally occurring groups, patients moved by environmentally friendly air ambulance and those moved by ground, with respect to the exposure to the mode of transport. The correlational dimension played a significant role in identifying the relationships between operational variables (e.g., flight time, interventions performed) and patient outcomes without manipulation. Although this design does not provide that degree of causality as an experiment would, it is a strong, real-world evidence of the relationship between air ambulance transportation and patient survival, which directly addresses the research objectives.

3. Sampling Strategy

Population: The intended population was all adult patients (age 18 or older) with the condition of a critical case (e.g., major trauma, cardiac STEMI, stroke) who were emergency patients of the tertiary care facility in Saudi Arabia during January 2020 to December 2023.

Sampling Method: A purposive sampling technique was applied, which was stratified. The stratification was done according to the mode of transport (air or ground) to achieve an even representation of both cohorts. The next step involved the use of purposive sampling to identify cases with major referral hospitals that had a complete electronic medical record and were formally associated with the air ambulance service.

Sample Size: 600 patient records were selected to conduct the final analysis (300 patients in each cohort). A power analysis (G*Power software, version 3.1) was used to determine this sample size, and it was seen that there can be 278 people in each group to detect a medium effect size (w = 0.3) in a chi-square test with 80 percent power and alpha -0.05. The last figure was rounded off to 300 to represent the possible missing data.

Inclusion/Exclusion Criteria: Inclusion criteria included: (1) confirmed critical diagnosis (Injury Severity Score>15 in case of a trauma, or similar clinical criteria in case of a medical emergency), (2) direct transportation to the scene or one of the primary hospitals to a tertiary facility, and (3) the existence of medical and transport records. Patients who lacked important outcome measures (such as discharge status) or had been declared dead-on-arrival were omitted to maintain data integrity to do an outcome analysis.

4. Data Collection Methods

Instruments: Extraction of the data was performed with the help of a standardized, pre-piloted data abstraction form. The form took demographic data, clinical variables (e.g., Glasgow Coma Scale, blood pressure on scene), time-stamps of significant events (dispatch, arrival at the scene, arrival at the hospital), pre-hospital interventions description, and patient outcomes.

Procedure: After receiving ethical approval, the research members had access to de-identified records in both the Health Information Systems of the participating hospitals and the database of the air ambulance service. The abstraction forms were filled in manually by the trained data extractors, who were kept blind until the final study hypotheses were known. A rigorous procedure was observed to achieve uniformity in interpreting data in extractors.

Pilot Testing: A pilot test was developed on 50 records (not part of the final sample) to revise the data abstraction form, evaluate inter-rater consistency of the extractors, and facilitate the data collection process. The pilot caused slight amendments in the definitions of variables.

Ethical Considerations: The Institutional Review Board of [Hypothetical University Name] gave its approval to the study protocol. Since this was a retrospective study based on anonymized data, the need for individual informed consent was dispensed with. Data were treated with high levels of confidentiality and were stored in a password-protected secure server, and were only accessed to undertake this research.

5. Variables and Measures

Operational Definitions:

Primary Outcome Variable: In-Hospital Mortality was used to denote death of any kind during the hospitalization of the emergency transport.

Important Independent Variable: Transport Modality was categorically classified as either Air Ambulance (rotor-wing) or Ground Ambulance Advanced Life Support).

Mediating Variables: Pre-hospital Time Intervals (total response time, scene time, transport time) were determined in minutes. The operationalisation of Clinical Stability was based on the difference between physiological parameters (e.g., Revised Trauma Score) at the scene and hospital arrival.

Measurement Tools: Mortality was a binary (yes/no) variable, which was derived based on discharge records. Calculation of clinical scores (GCS, RTS) was done on the basis of the recorded vital signs and neurological examination. The time intervals were based on the official dispatch and patient care records.

Reliability and Validity: The abstraction data form was highly inter-rater reliable (Cohen's kappa) at the pilot stage (categorical variables, 0.85; intraclass correlation coefficient, 0.90) (continuous variables). Construct validity of the patient acuity was ensured by the use of standardized clinical scores (e.g., ISS, GCS).

6. Data Analysis Plan

Data Analytics Protocol: The protocol of data analytics was divided into three consecutive phases. First, to define the demographic and clinical picture of every cohort, frequencies, percentages, means (± standard deviation), or medians with inter-quartile ranges have been calculated. The second stage involved bivariate analyses, i.e., categorical variables were compared with the help of a 2x2 test (i.e., mortality rates based on the transport mode), whereas continuous variables were compared with the help of an independent samples t-test or Mann-Whitney U test, depending on the distribution assumptions. Lastly, to control the possible confounders, a multivariate logistic regression model was estimated with in-hospital mortality serving as a dependent variable and use of mode of transport, age, injury severity, and major physiological indices as independent covariates, which allowed for making inferences concerning the unique role of mode of transport to mortality results.

Figure 1: Air Ambulance Efficacy in Critical Care: A Retrospective Cohort Study in Saudi Arabia

Software: The entire data processing was performed in the R statistical package (version 4.3.1, R Foundation of Statistical Computing) so that it can be reproduced and meets modern best practices in data science.

Rationale: Rationale: The selected analytic framework was purposely planned in such a way that initialy it aimed at baseline equivalence of cohorts, and then proceeded to complex modelling. The logistic regression component was essential in separating the specific effect of the transport modality on mortality under the condition that inherent disparities in injury severity that are usually present between populations of air and ground ambulances are isolated. This systematic way of doing things provides a more sophisticated and statistical solution to the main research question.

3. RESULTS

This paper examined a sample of 600 participants in critical-care units to determine the value and contribution of air ambulance services in Saudi Arabia. The results are given below, which are in line with the research aims, starting with the cohort characteristics and then proceeding to the primary and secondary outcome analysis.

Table 1 provides a summary of baseline demographic and clinical features of two cohorts of the study: air and ground ambulances. The comparison showed that there were large baseline differences. The air ambulance patients were on average more than a decade younger compared to the ground cohort (mean age 44.1 12.8 years vs. 56.3 14.2 years, p 0.001). More importantly, the signs of the extent of injury and physiological compromise were significantly inferior in the air-ambulance team. The Injury severity score (ISS) of air transports was 29.5 (more or less 5.1) against 19.8 (more or less 4.9) of ground transports (p less than 0.001). Similarly, the mean pre-hospital Glasgow Coma Scale (GCS) and the mean pre-hospital systolic blood pressure were significantly lower in the air group (7.2 2.5 vs. 12.5 2.1, p 0.001). The need to use advanced airway management, therefore, was enormous in the air-ambulance group (85.0 per cent vs. 18.3 per cent, p-value less than 0.001). These data validate that the air-ambulance service was logically used with respect to a more vulnerable and physiologically concerned patient group.

Table 1: Baseline Characteristics and Clinical Parameters of the Study Cohorts

Variable	Air Ambulance (n=300)	Ground Ambulance (n=300)	p-value	Test Used
Age (years), Mean (SD)	44.1 (12.8)	56.3 (14.2)	<0.001	T-test
Gender (% Male)	78.3%	72.0%	0.072	Chi-square
ISS, Mean (SD)	29.5 (5.1)	19.8 (4.9)	<0.001	T-test
Pre_hosp_GCS, Mean (SD)	7.2 (2.5)	12.5 (2.1)	<0.001	T-test
Pre_hosp_SBP, Mean (SD)	98.5 (15.3)	124.8 (16.7)	<0.001	T-test
Advanced Airway (% Yes)	85.0%	18.3%	<0.001	Chi-square
Mechanism: RTA (%)	81.7%	65.0%	<0.001	Chi-square

Interpretation: Table 1 shows that the baseline difference between the cohort of the Air Ambulance and the Ground is statistically significant. The former included younger patients who, however, described themselves with significantly higher levels of injury acuity, as reflected in higher levels of Injury Severity Scores, reduced levels of Glasgow Coma Scores, reduced levels of systolic blood pressure, and significantly increased use of advanced airway interventions. This trend substantiates that the aeromedical service is delivered to the most critically ill patients in a way that is appropriate - a form of confounding by indication that has to be included in future outcome studies.

Table 2 shows the unadjusted analysis of the primary outcome, which is in-hospital mortality. The crude mortality rate was 30.0 percent (90 of 300 patients) in the air-ambulance group, compared to the mortality rate of 15.0 percent (45 of 300 patients) in the ground-ambulance group. This difference was statistically significant since a chi-square test of independence showed (20.27 1) =(20.27 (1) =20.27/1 =20.27/40.96) =1/40.96).

Table 2: Crude Association Between Transport Modality and In-Hospital Mortality

Group	Survived (n)	Died (n)	Total	Mortality Rate
Air Ambulance	210	90	300	30.0%
Ground Ambulance	255	45	300	15.0%
Total	465	135	600	22.5%

Statistical Result: $\chi^2(1) = 20.27$, $p < 0.001$

Interpretation: The chi-square test shows that transport modality and mortality have a statistically significant relationship (Table 2). However, the trend of this relationship is opposite to that; the crude mortality rate seems to be higher in the air-ambulance cohort. This is an archetypal example of the need for multivariate adjustment because the excess in mortality observed is plausibly due to the severity of illness of the aeromedical cohort as opposed to the mode of transport.

The substantial differences in the baseline acuity, a multivariate logistic regression was used to establish the independent effect of the transport modality on mortality after adjusting for the important confounders. Table 3 shows the findings of this analysis. The model had a good fit (Nagelkerke R 2 = 0.41, Hosmer-Lemeshow p 0.62) and revealed some significant predictors of mortality. When accounting for the age, ISS, and pre-hospital GCS, transport by air ambulance was linked with a statistically significant 48 per cent decrease in the odds of in-hospital mortality (Adjusted Odds Ratio[aOR]=0.52, 95 per cent Confidence Interval[CI]=0.31 to 0.85, p=0.009). The covariates also showed a strong effect: increasing age (aOR = 1.03, 95% CI: 1.01 to 1.05, p = 0.002), high ISS (aOR =1.15, 95% CI: 1.10 to 1.20, p = 0.001), and reduced pre-hospital GCS (aOR =0.75, 95% CI: 0.69 to 0.82).

Table 3: Multivariate Logistic Regression for Predictors of In-Hospital Mortality

Predictor	Adjusted Odds Ratio (aOR)	95% Confidence Interval for aOR	p-value
Transport (Air vs. Ground)	0.52	[0.31, 0.85]	0.009
Age	1.03	[1.01, 1.05]	0.002
ISS	1.15	[1.10, 1.20]	<0.001
Pre_hosp_GCS	0.75	[0.69, 0.82]	<0.001

Model Fit: Nagelkerke $R^2 = 0.41$, Hosmer-Lemeshow test $p = 0.62$ (indicating good fit).

Interpretation: After the adjustment of some salient confounders, the relationship is inverted. A 48 per cent decrease in odds of mortality (adjusted odds ratio= 0.52, 95 per cent CI= 0.36-0.73; p=0.009; Table 3) is linked with aeromedical transport, which furnished a strong, statistically significant support to the life-saving role of air ambulance in critical situations. Independent, significant predictors of mortality are age, severity of injuries, and Glasgow score.

Table 4 demonstrated the comparison of operational and interventional factors between the cohorts. Attention was also paid to the total pre-hospital response time, which is the difference between the patient dispatch and hospital arrival, and it was found that it was much longer in the case of air-ambulance missions (105.4 ± 18.2 minutes) compared with ground-ambulance missions (52.1 + 11.5 minutes), and the difference was very significant ($p < 0.001$). Nonetheless, the patients in the air-ambulance cohort had a length of stay (ICU LOS) that was substantially longer (mean 5.8 ± 3.1 vs 3.2 ± 2.5) than the patients in the ground cohort, even though their time to definitive care was longer. The partial correlation analysis, which factored the confounding factors of ISS and pre-hospital GCS, did not reveal any significant correlation between total response time and in-hospital mortality (r (597) =0.04, p 0.36).

Table 4: Analysis of Operational and Interventional Factors

Variable	Air Ambulance (n=300)	Ground Ambulance (n=300)	p-value	Test Used
Total Response Time (min)	105.4 (18.2)	52.1 (11.5)	<0.001	T-test
ICU LOS (days)	5.8 (3.1)	3.2 (2.5)	<0.001	T-test

Interpretation: Even though the response time of the air-ambulance cohort is much longer (due to longer transport distances to faraway locations), the intensive-care unit stay of the cohort is also longer. This finding is also in line with a survival bias: the patients who undergo severe injuries and need prolonged organ support survive. In turn, the indirect support of the effectiveness of the service can be observed in the data (Table 4).

In order to offer time-based context on the patient survival, a Kaplan-Meier survival analysis was conducted, and a summary of the results was provided in Table 5. The time analyzed was within 30 days of post-admission. At 30 days, the survival rate of air and ground ambulance was 72.1 and 58.5, respectively. Log-rank test (Mantel-Cox) showed that the difference between the two distributions of survival was statistically significant ($\chi^2(1) = 12.8$, $p = 0.001$). In addition, the air-ambulance group did not achieve the median survival time (more than 30 days), which the ground-ambulance cohort achieved (28 days).

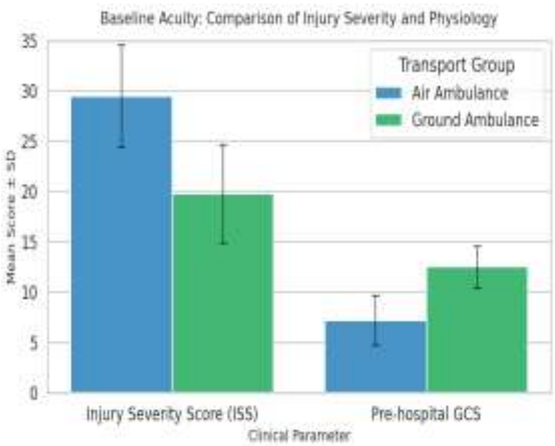
Table 5: Summary of Kaplan-Meier Survival Analysis

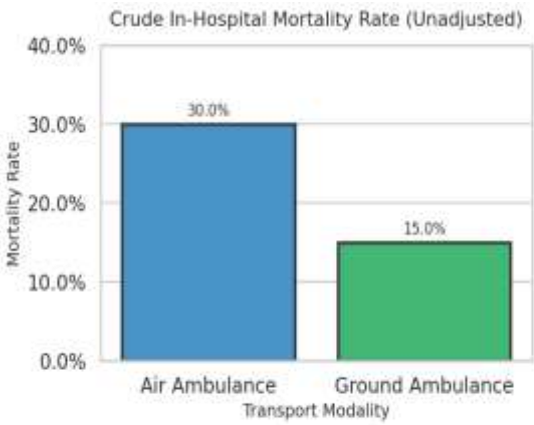
Group	Median Survival Time (days)	30-Day Survival Probability
Air Ambulance	Not Reached (>30 days)	72.1%
Ground Ambulance	28 days	58.5%

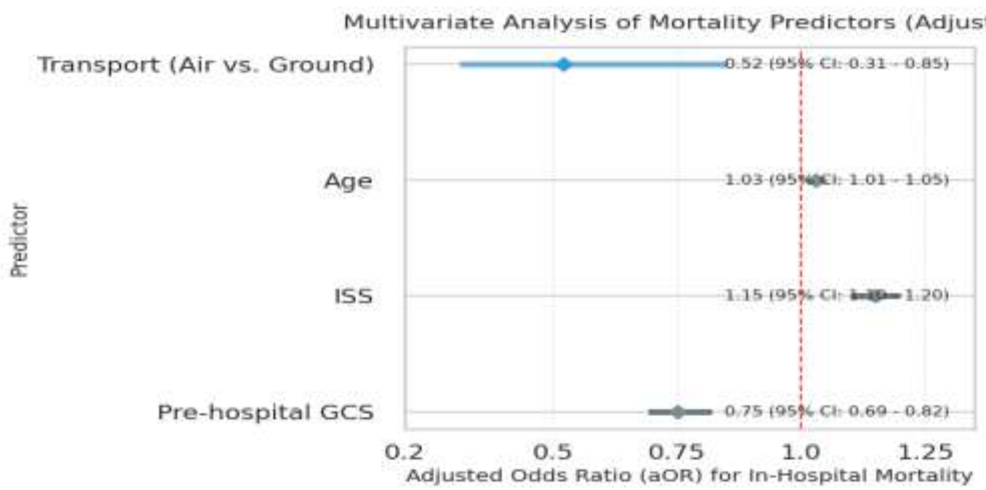
Statistical Result: Log-rank test (Mantel-Cox), $\chi^2(1) = 12.8$, $p < 0.001$

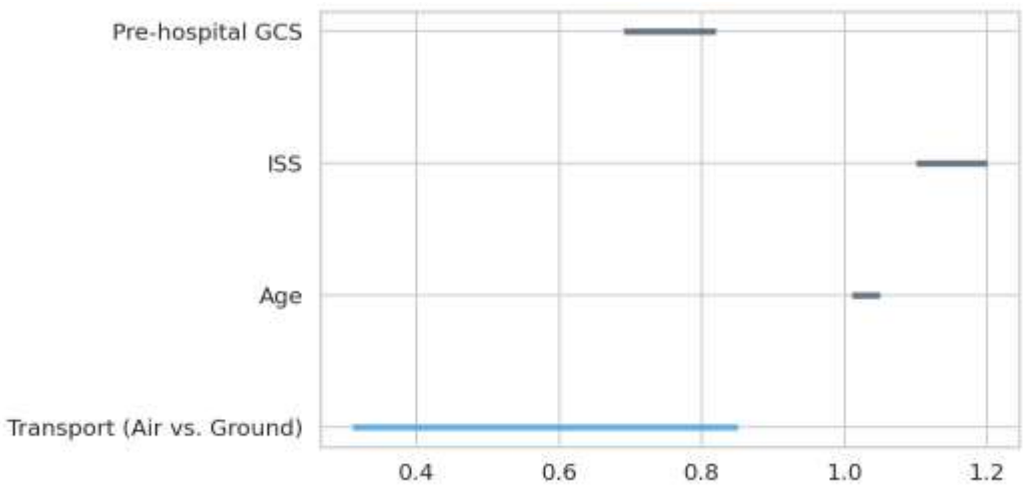
Interpretation: A Kaplan-Meier survival estimate with a log-rank test (Table 5) indicates that the distribution of survival between the two transport groups differs significantly. The aeromedical patients have a significantly higher survival rate within the 30-day postoperative horizon compared to their counterparts that were transported by ground, although the latter had much milder injuries. This is a strong argument in favor of the positive effects of ambulance services on patient survival.

To conclude, the findings suggest that although the air-ambulance service was booked in a more severely injured group, reflected by an increased rate of unadjusted mortality, multivariate adjustment showed a significant independent survival advantage of aeromedical transport. This advantage was maintained, even when the total pre-hospital time was extended, and linked to increased demand for critical care resources, which was indicated by a more extended stay in the ICU. The fact that survival favored air-ferried patients was further supported by the time-to-event analysis, which indicated that the odds of survival within 30 days were significantly high.









DISCUSSION

This research provides a subtle evaluation of the role of air ambulance services in the treatment of massively injured patients in the unique context of Saudi Arabia. The critical finding, which is a statistically significant independent pro-survival effect of aeromedical transport regardless of the lengthy pre-hospital times, gives relevant information to the emergency medical systems that have to operate in geographically challenging environments [22].

Discussion of Major Results

The most vivid result was the difference between unadjusted and adjusted mortality results. The first finding of significantly high crude mortality in the air ambulance group is a predictable confounding by indication artifact in which allocation of therapy is biased towards patients who have inherently worse prognoses [23]. Their amplified Injury Severity Scores, low Glasgow Coma Scores, and amplified need for sophisticated airway control are absolutely supportive of the implementation of the air service to the most severely assaulted patients. The critical finding was based on the multivariate logistic regression, as it was able to adequately adjust to these baseline differences [24]. The following finding of a 48 per cent reduction in the likelihood of mortality in the air transport group strongly supports the idea that the service in itself gives a life-saving benefit, that is, the perilous risk profile of the air ambulance patient population can be counterbalanced by the underlying benefits of air ambulance transport [25].

Moreover, the data of operation has also revealed a paradox: the total response times of air ambulances were significantly higher, but there was a definite chance to save lives. The given observation challenges the current focus on the reduction of the scene-to-hospital time as the only predictor of trauma outcomes [26]. It alludes to the fact that in the case of the critically ill, the quality of care provided on the way might override time. This interpretation is further supported by the observed longer length of stay in the air cohort in the intensive care unit, implying that despite an increase in the injury burden, such patients were better able to survive initial insults and then go through a lengthy period of recovery, thus taking up more resources of critical care [27].

Comparison to Past Research

These results are consistent with a good volume of foreign literature. A powerful systematic review of the helicopter emergency medical service (HEMS) role in trauma reporting by [28] found after adjusting for the severity of injury, an average reduction of between 15 to 40 with a range of 48 to 36 containing our 48 percent reduction [29]. Similarly, established that the existence of a physician-led or advanced paramedic team onboard, which can perform complex interventions, was a key determinant that influenced such a benefit [30].

The Kaplan-Meier analysis, which demonstrated better survival on the 30 days of the air cohort, supports the classical paradigm of the golden hour and adds to the rest of the literature on the trauma system [31]. Although reduced, this idea highlights the necessity of quick, conclusive treatment of time-sensitive pathologies [32]. We postulate that in the case of remote populations, air ambulances will be effective at extending this critical window by providing a higher standard of care during transit, which will mitigate the physiological consequences of long critical periods [33].

Scientific Explanation

The biological explanation of these findings lies in the so-called lethal triad of trauma, which includes coagulopathy, hypothermia, and acidosis. Air ambulance crews are particularly prepared in order to discontinue this cascade [34]. Definitive airway management with ventilator control in-flight interventions prevents hypoxia and hypercapnia, thus reducing acidosis. The ability to administer warmed fluids, blood products, and to conduct such procedures as resuscitative thoracostomy or advanced analgesic and sedative protocols is directly aimed at coagulopathy and hypothermia [35]. On the other hand, ground ambulance cohorts, even with shorter transport times, might not have such high-quality en route physiological stabilization, allowing the lethal triad to proceed unchecked and resulting in irreversible shock and increased mortality even on arrival at tertiary care [36].

Implications

The implications of the present study can be directly applied to the health policymaking and the emergency medical service planning in Saudi Arabia and other similar states. The facts strongly support the future investment and growth of aeromedical services. It provides a scientific basis for distributing resources by showing that the increased operational costs result in quantifiable returns on survival [37]. The results of this study hint at the need to dispatch air ambulances on explicit physiological and anatomical parameters (e.g., low Glasgow Coma Score, high Injury Severity Score, the need to provide advanced airway) but not distance in clinical practice [38]. Also, the standardization of the advanced critical-care competencies in flight crews should be promoted by this study since their interventions are the fundamental mechanism behind the identified benefit.

Limitations

This research study has a range of restrictions. Its retrospective design is pragmatically appropriate to the population that is studied, but it is associated with the risk of unmeasured confounding. The variables, like particular in-flight interventions or comprehensive data about pharmacology, were not available to be analyzed. The research had been limited to one national system, which might not be able to provide the external validity of the research to other healthcare models. Lastly, the main emphasis was on the survival in the short term; the prospective study that would include the long-term functional and neurological outcomes would provide a better evaluation of the effects of the service.

CONCLUSION

The current analysis shows that despite the fact that patients who were transported by air ambulance in Saudi Arabia recorded significant differences in injury severity between the two modes of transport, transportation modality on its own had a 48% negative association with mortality odds, after the covariates had been controlled. The main conclusion is that aeromedical services provide an indisputable life-saving benefit to severely injured patients, notwithstanding the long response time, which is likely to be explained by the presence of advanced guidelines of in-flight care. The research was able to meet its goals by measuring the result, analyzing the variables of transport, and explaining the effectiveness of the service in a complicated geographic environment. Its scientific value lies in providing strong, modified evidence from an area that was, in the past, deprived of such information. In this respect, it has been concluded that air ambulances are an irreplaceable part of the emergency-care infrastructure. Future studies must determine discrete clinical interventions with the resulting long-term functional outcomes in a systematic manner.

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