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The effectiveness of air ambulance units in reducing mortality rates resulting from traffic accidents far from urban centers

Ibrahim Muslih Abdurahman Althagafi[1],Waslallah Azib Q Althobaiti[2],Mohammed Abed Obaid Althobaiti[3], Saud Saeed Awad Aljuaid[4], Hani Hussain Muid Althobaiti[5],Nasser Abdullah Hasan Alghamdi[6],Fahad Abdrabuh Radah Altalhi[7],Abdulraman Obaid Muaysib Alsufyani[8],Bandar Dhubaya Ahmed Alsufyani[9]

[1-9]Emergency Medical Technician – Saudi Red Crescent Authority, Makkah Region (Taif)

Abstract

This research aims to study the effectiveness of air ambulance units in reducing mortality rates resulting from traffic accidents occurring in areas remote from urban centers in the Kingdom of Saudi Arabia. The researcher used a 12-item questionnaire to measure participants' views on the speed of response, readiness of medical equipment, field coordination, and the level of satisfaction of injured people and their families with the services provided. The statistical results showed that the overall average of responses was 4.14, indicating a high level of agreement on the effectiveness of air ambulance units. Pearson correlation analysis also showed statistically significant relationships between all study dimensions, with response speed, equipment readiness, and field coordination being positively correlated with overall satisfaction. These findings indicate that enhancing integration between air and ground ambulance teams, and equipping units with modern technologies and specialized training, directly contributes to improving the quality of emergency services and reducing deaths in remote areas. The study recommends increased investment in air ambulance infrastructure and expanding its operations to cover wider areas, ensuring equitable provision of emergency healthcare between urban and rural populations.

Keywords: Air ambulance, mortality rates, traffic accidents, response time, quality of health services, field coordination, Saudi Red Crescent.

Introduction

Air ambulance units play ,A vital role in improving the survival chances of traffic accident victims especially those in remote areas far from urban centers and specialized hospitals. The primary effectiveness of these units lies in their ability to overcome geographical obstacles and traffic congestion, significantly reducing response time. This is the critical period when rapid medical interventions are most important to save the life of the injured person. Rapid and safe transport also ensures the arrival of specialized medical teams and life-saving equipment to the accident site as quickly as possible, and then transferring the injured person to an advanced medical facility in record time. This directly translates into a tangible reduction in mortality rates and mitigation of complications. The greatest contribution of air ambulances is evident in complex and serious injury accidents that require immediate surgical intervention or specialized intensive care, such as head and chest injuries and internal bleeding. Road infrastructure in rural and remote areas is often not equipped for rapid response, as land ambulances may take hours to arrive and transport, increasing the risk of losing the injured person. In contrast, helicopters provide a platform similar to a flying intensive care unit, staffed with doctors and paramedics trained in field emergency medicine to provide advanced care, such as resuscitation and bleeding control, before and during transport. This ability to initiate rapid and intensive treatment en route to the hospital is a critical factor in increasing the chances of survival for critically injured patients1,2

Discussion

Studies and statistics also indicate a clear positive correlation between the use of air ambulance services and reduced mortality rates from road traffic accidents in areas with limited medical coverage. The role of these units is not limited to rapid transport only, but extends to include improving the quality of emergency care provided in difficult field environments. To achieve maximum effectiveness, effective integration ,between air ambulance services, ground medical protocols, and geographic positioning systems is required in addition to continuous investment in training medical personnel and equipping aircraft with the latest technology. This integrated approach establishes air ambulance as an indispensable tool in strategies to reduce road traffic deaths in remote areas. However, the air ambulance system in remote areas faces logistical and operational challenges that require innovative solutions to ensure the sustainability and effectiveness of the service3,7

These challenges include the high cost of operating and maintaining aircraft and the need to provide an integrated network of airstrips near highways and reference medical centers. In addition, there is the need to deal with adverse weather conditions that may hinder flight operations. To overcome this, investment in .advanced technology, such as the use of artificial intelligence systems, is necessary To improve aircraft dispatch operations, determine optimal routes, and deploy advanced communication platforms to exchange medical data on injured patients in real time between the air team and the receiving hospital. Establishing public-private partnerships also contributes to securing the necessary funding and improving geographic coverage, enhancing these units' ability to reach them quickly and save more lives8,3

- **Air Ambulance Unit Concept**

Air ambulance units, also known as air medical emergency services, are an integrated and specialized healthcare system that aims to rapidly transport patients and injured people by aircraft, whether helicopters or fixed-wing aircraft. The primary function of these units is to reduce response time in critical emergency situations, especially when accident sites are remote or difficult to reach by land due to geographical obstacles or traffic congestion. Their role is not limited to transportation alone, but also includes providing advanced medical care during the flight, making them an emergency room. What distinguishes air .ambulance units is their high level of equipment and the quality of the medical crews working on board The aircraft are equipped with advanced medical equipment comparable to that found in intensive care units, such as ventilators, vital signs monitors, intravenous infusion pumps, resuscitation equipment, and bleeding control. The operating crews usually consist of doctors specializing in emergency medicine or anesthesia, highly qualified emergency paramedics, and professional flight crews. This configuration allows for the initiation of complex life-saving procedures on site and during transport, such as airway .stabilization and minor surgical interventions in the field8,9

Air ambulances are mainly used in scenarios that require extreme speed or specialized medical expertise that is not always available in regular ground ambulances. Their most important uses are serious injury incidents such as traffic accidents and work accidents that occur on highways or in rural areas, as they are .used to transport patients with critical medical conditions such as strokes or heart attacks From small hospitals to specialized care centers It also plays an important role in search and rescue operations in rugged areas. Speed in these cases means reaching definitive care within minutes, which significantly increases the chances of survival and recovery without serious complications. Therefore, air ambulance units prove highly effective in reducing mortality rates and improving treatment outcomes, especially in countries with vast areas or difficult terrain. However, this concept faces fundamental challenges that include several :criteria, including ,The high cost of operation and maintenance, the need for adequate airstrip infrastructure and the constraints imposed by adverse weather conditions and night operations to ensure maximum benefit, these units must be an integral part of an integrated emergency system that includes effective coordination with ground ambulance services, hospitals, and control and monitoring centers, and the use .of the latest geolocation and communications technologies1,3

Therefore, air ambulance units are an advanced strategy in providing emergency healthcare that is centered around a dual goal: achieving the highest possible speed of medical transport and providing specialized .and intensive medical care in the transport environment They are not limited to being a mere means of air .transport, but rather are a field extension of intensive care units equipped with highly trained medical staff These units are the ideal solution for overcoming the barriers of distance and time, ensuring that victims .of critical cases, such as remote road accidents, reach final treatment facilities within the critical timeframe .This translates directly into a tangible reduction in mortality rates and increased chances of recovery2,8

- **Air ambulance objectives and its role in emergency response**

The main and primary goal of air ambulance units is to reduce Time period To the maximum extent possible, this is the critical period during which a severely injured person must receive specialized final care to ensure the best chance of survival. Air ambulances succeed in achieving this due to their high speed and ability to overcome ground obstacles such as traffic jams, long distances, and rough terrain such as mountains or deserts. This rapid transport ensures that those injured in remote areas can reach critical care .hospitals Specialized In record time, this is a pivotal role that ground ambulances cannot perform with the same efficiency. Therefore, the role of air ambulances is not limited to rapid transport only, but extends to include providing advanced medical care at the scene of the accident. The medical crews on board the aircraft usually include an emergency physician and an advanced paramedic and are equipped to perform life-saving interventions that go beyond what is usually available in ground ambulances, such as securing .an advanced airway, controlling severe bleeding, and advanced cardiopulmonary resuscitation procedures This ensures that treatment of the injured person begins immediately upon the team's arrival, preventing .the deterioration of his condition during the transport period9,10

.Air ambulance aims to support the healthcare network through transportation between medical facilities Patients with critical and complex conditions, such as victims of major burns, patients requiring organ transplants , or newborns who require specialized incubators, are transported from small hospitals with limited capacity to university and specialized medical centers equipped with the highest levels of technology and care. This transport is carried out safely and under constant and continuous medical supervision, which ensures the continuity of treatment and does not put the patient's life at risk during the long transport journey . Air ambulance is also an essential component of disaster response plans and search .and rescue missions In the event of natural disasters such as earthquakes, floods, or mass casualty incidents, aircraft can reach affected areas whose roads may be destroyed or closed, enabling the evacuation of large numbers of injured people and the transport of vital medical supplies. Helicopters also play an indispensable role in searching for missing persons in mountainous or marine areas and dropping trained rescue teams directly to the scene of the event, enhancing the country's overall ability to respond effectively .to any large-scale emergency11,5

Therefore, the objective of air ambulance units in establishing a high-speed and flexible medical safety network is to overcome time and space barriers in emergency situations. The goal is not only to transport the injured person, but also to provide life-saving treatment during the most critical minutes and ensure that the injured person reaches the best possible level of definitive care without delay. In other words, these units seek to balance the time and medical gap between the remote site of injury and the equipped medical .center. This is achieved by combining maximum speed of transport with advanced medical specialization The ultimate goal is to increase survival rates and reduce disability resulting from injuries and critical .illnesses, making them a vital investment in achieving national health security8,9

- **The importance of air ambulance in saving lives and reducing arrival time**

The ultimate importance of air ambulance is evident in its ability to reduce the critical time period immediately following an injury, when emergency medical interventions are most effective in saving the life of the injured person. In major trauma accidents, every minute of delay can significantly increase the ,likelihood of death or permanent disability. Helicopters and aircraft work to overcome all ground obstacles

.whether heavy traffic congestion within cities or rugged terrain, as well as vast distances in remote areas .This means ensuring the patient reaches a specialized trauma center In a short period of time, which can mean the difference between life and death, air ambulances also play a significant role in expanding the scope of emergency medical care to include areas that were previously considered out of reach or difficult to reach quickly, such as rural areas, mountainous and desert locations, islands, and highways far from major urban centers. All of these areas directly benefit from the ability of aircraft to reach them directly ,and efficiently. When accidents occur in these locations, ground ambulances may take hours to arrive while air ambulance units can arrive in minutes, allowing the necessary care to be provided and the injured person evacuated before his condition deteriorates, which significantly reduces the death rate associated .with accidents in these areas8,2

The importance of air ambulance is not limited to speed alone, but extends to the quality of medical care ,provided. The aircraft is not just a transport vehicle, it is a fully integrated and portable intensive care unit and the air medical crews are specialized doctors and paramedics qualified to perform advanced and critical .medical interventions such as resuscitation, management of severe bleeding, and intubation during flight This ability to initiate rapid and effective treatment in the field and during transport ensures the stability of the critical patient's condition and increases his chance of survival until reaching the operating room. Rapid transport coupled with high-quality treatment is the basis of the effectiveness of these units. Therefore, air ambulance is an indispensable tool in dealing with accidents and mass disasters when major accidents occur that cause a large number of injuries. Aircraft can also play a dual role in Triaging the injured and quickly transporting the most critical cases to different hospitals simultaneously reduces the pressure on a single hospital. It also facilitates the immediate transfer of medical resources and specialized surgical teams to the disaster site if necessary. This flexibility and speed in transporting both the injured and resources are essential factors in improving disaster management and mitigating the human damage caused by them9,1

Therefore, the importance of air ambulance lies in its ability to provide effective and rapid access to definitive care during life-or-death situations. The importance is based on the principle that speed equals life. Air ambulance serves as a powerful tool to break the barriers of time and distance, allowing for the isolation of injured people in remote areas to end. It not only reduces the time it takes for the injured to arrive, but also ensures that the transport is accompanied by advanced and continuous medical care by specialized crews. This combination of extreme speed and high medical quality significantly increases the .likelihood of survival for those injured in critical conditions and reduces long-term damage

- **Factors affecting the effectiveness of air ambulance units**

The primary effectiveness of air ambulance units depends on the speed and efficiency of operation and strategic geographical distribution. The decisive factor here is the dispatch time, which is the period of time between receiving the report and the helicopter taking off. This time must be very short and supported by advanced communication and navigation systems such as advanced positioning systems. In addition, air ambulance bases must be distributed near highways and remote areas to ensure wide coverage and rapid access to danger points. The closer the bases are to common accident sites, the faster the response and the shorter the final arrival time for the injured person. The level of medical care provided on board the aircraft is a very influential factor in the ultimate effectiveness of saving lives. It is not enough for the aircraft to .be fast; it must also serve as a flying intensive care unit Equipped with the latest technology, including advanced ventilators, vital signs monitoring equipment, and emergency surgical intervention tools, the most important thing is the qualification of the medical staff, as the team must consist of doctors and .paramedics with advanced experience in field emergency medicine They are able to make important decisions and perform complex interventions under pressure and in difficult flight conditions. This medical .specialization is what turns rapid transport into actual life-saving9,3

Integration and coordination between air ambulances and other agencies also directly impacts effectiveness, requiring clear protocols for cooperation with ground ambulances, control and monitoring .centers, and receiving hospitals Hospitals must be prepared to receive airborne patients and have teams

ready upon arrival. In addition, environmental and logistical conditions play a pivotal role. Adverse weather ,conditions, such as heavy fog or storms, can lead to the postponement or cancellation of air missions reducing effectiveness. Therefore, investing in night flight technology and weather-resistant navigation .systems is essential to ensure round-the-clock readiness6,7

- **Operational challenges in areas far from urban centers**

The lack of aviation infrastructure is one of the most significant challenges in remote areas, as these areas .often lack airstrips Equipped and lit near highways or small rural hospitals, this forces crews to land in unprepared locations, increasing risks. Furthermore, remote areas suffer from poor or non-existent radio and data coverage, complicating immediate coordination between the aircraft, the control center, and the hospital in the future. This lack of communication hinders the exchange of vital medical information in real time and reduces the effectiveness of evacuation and transport operations. Harsh environmental and geographic conditions also impose significant operational restrictions on flying in remote areas. These restrictions include volatile weather conditions, such as dense fog in mountainous areas or sandstorms in desert areas, which may force aircraft to delay or cancel missions for safety reasons. Furthermore, rugged terrain poses challenges in identifying safe and rapid landing sites and may require the use of advanced .and expensive aviation technologies6,5

Night flying in these areas presents an additional challenge due to the lack of ground markings and navigation aids, requiring aircraft equipped with night vision goggles(NVGs) and specially trained flight .crews5,1

.In addition, operations in remote areas face logistical challenges related to fuel supplies and maintenance Helicopters require regular refueling, and aircraft fueling stations are often located far from accident landing sites, lengthening the operational cycle. As for maintenance and technical support, keeping aircraft in a state of high readiness requires the availability of technicians and spare parts. Due to the distance between operating bases and main centers, maintenance and repair operations may take longer and be more expensive, leading to reduced fleet readiness and thus reducing the overall effectiveness of emergency .response

Accordingly, the operational challenges facing air ambulance units in remote areas can be explained in :three main axes Lack of infrastructure, environmental and geographical constraints, and logistical difficulties. In remote areas, the lack of safe airstrips and weak communication networks pose challenges that hinder landing speed and coordination. Environmental challenges include weather fluctuations and rugged terrain, which limit safe operating hours, especially at night. These units also face difficulties securing logistical support such as fuel and maintenance, which impacts aircraft readiness. All of these factors make maintaining a high level of effectiveness and readiness in remote environments more complex .and costly8,6

- **The relationship between air response speed and mortality rates**

There is a direct, inverse relationship between the speed of air response and mortality rates. The faster the response, the more significantly the mortality rates decrease. This relationship is centered around one concept: the critical time frame, which is usually the first 60 minutes after the injury, during which medical interventions are most effective in saving the lives of those with major injuries. The value of air ambulance lies in its ability to shorten the time to reach the accident site and then transport the injured person very .quickly to the trauma center This speed ensures that the patient receives the necessary surgical or intensive care before his condition deteriorates beyond repair, effectively reducing the chances of death. The relationship is not only related to speed, but also to how this short time is used. When the air ambulance unit reaches the injured person at high speed, it not only begins the transport process, but its specialized .teams, which include a doctor or advanced paramedic, begin providing advanced medical care During the flight, this care includes vital measures such as securing the airway and effectively controlling internal or

external bleeding, which is known as pre-hospital medicine. These rapid and advanced interventions work to stabilize the patient's condition in the air, so when the patient arrives at the hospital, he has a much greater chance of survival than someone who was transported late without specialized medical .intervention6,9

This inverse relationship is more evident in areas far from urban centers. In these areas, ground response times are very long, which increases mortality rates due to fatal delays in care. Here, air ambulance .becomes the main determinant of survival Many of Studies in advanced emergency systems show that critically injured patients requiring urgent surgical intervention who are airlifted reach definitive care sooner and exhibit significantly lower mortality rates than those transported conventionally under similar circumstances. This confirms that the speed and skill of an airborne response are critical factors in saving .lives and reducing disability10,1

- **International experiences in using air ambulances for traffic accidents**

:There are two models for using air ambulances for traffic accidents, which can be explained as follows Germany is the world leader in applying air ambulance services, as the German Automobile Club plays a .role ,A pivotal role, as the German model relies on a dense network of strategically distributed air bases ensuring that helicopters can cover any point in the country and reach it within 15 Approximately one minute of flight time. These units are distinguished by the mandatory employment of an emergency medicine specialist and an advanced paramedic on board each flight8,1

This speed of response, which reduces the arrival time compared to the presence of a highly specialized medical team at the accident site, has contributed significantly to the reduction in death rates resulting from road accidents on highways and rural areas, making it a global standard. The second model, the United States of America, is distinguished by the use of air ambulances, focusing on transporting critical trauma .cases To accredited trauma centers Given the vast distances between urban centers and rural areas, ground ambulances cannot achieve the required transport time. Air ambulances, often operated by private companies or large hospitals, are immediately deployed for highway collisions and in sparsely populated states. US statistics have clearly shown that the use of helicopters to transport traffic accident victims has significantly improved outcomes for those with multiple severe injuries, highlighting the critical .importance of rapid and direct transport to specialized care5,9

- **Integration between air and ground ambulance units in the emergency system**

Effective integration between air and ground ambulance begins at the initial dispatch and prioritization .stage Once the control center receives a report of a traffic accident, especially in remote areas, strict protocols are applied to assess the severity of the injuries and the geographical location. If the injuries are classified as critical trauma and require rapid intervention beyond the capabilities of the local ground ambulance, the aircraft is immediately dispatched in conjunction with the ground ambulances. The ground ,crew works to secure the accident area, prepare the injured person, and prepare a landing site if necessary ensuring that the aircraft’s arrival has immediate added value8,2

The most important aspect of integration in field care and joint transport is when the ground and air teams .meet at the accident site, where their efforts are combined to provide the best care for the injured person The information gathered by the ground team is transferred to the doctor and advanced air paramedic to determine the intervention plan. The air team may perform complex interventions, such as injecting specialized medications, and then the patient is transferred to the aircraft for In other cases, the ground team may transport the patient a short distance to a pre-determined meeting point, where they are transferred to the aircraft for the onward journey to the specialized medical center. This cooperation ensures that no valuable time is wasted on-site8,1

Therefore, logistical integration is essential to ensure the sustainability and effectiveness of the entire system. Air ambulance units undertake the rapid transport of critical cases that cannot be transported by

land, while ground ambulances cover less critical cases and ensure the continuity of essential care in nearby areas. Coordination also takes place to share resources. Sometimes, hospital ground ambulances may use air ambulance units' helipads, and technical information about road conditions or designated landing sites is exchanged. This patient-centered, integrated work ensures that there are no gaps in the emergency care .chain and optimizes the use of both means according to the severity of the injury and the distance involved

- **Regulatory and legislative foundations for air ambulance services**

Air ambulance services are subject to strict oversight by local and international civil aviation authorities .such as the US Federal Aviation Administration or the European Aviation Safety Agency Regulatory ,principles in this area include aircraft licensing, ensuring their maintenance according to strict standards training flight crews to fly in all weather conditions, emergency medical transport missions, and determining safe operating rules such as permitted flight hours, landing and take-off procedures in unprepared locations, and the use of navigation and communication systems. The primary objective of these rules is to ensure the safety of the crew and the patient during the flight. Air ambulance services are also subject to health and medical legislation that regulates the level of care provided. These legislations require air medical crews, doctors, and paramedics, to obtain specialized licenses and experience in .emergency medicine and critical care provided outside the hospital It also includes the establishment of unified medical protocols for all critical cases, such as trauma injuries, heart attacks, and strokes, to ensure quality care. These regulations also require the availability of specific medical equipment onboard aircraft that is compatible with advanced care standards, and specify standards for medical documentation and .reporting of cases9,7

Air ambulance services also require a clear legal framework to define legal and civil liability in the event of accidents or medical errors during transport. Legislation must also define the relationship between the service provider (the aircraft operator) and the medical institution supervising the team. From an organizational perspective, funding is an important issue. Laws typically specify how these services are financed—whether as a public government service, through health insurance, or through private companies—and the mechanisms that ensure their financial sustainability. They also establish rules to .ensure equitable access to this service for all citizens, regardless of their location or economic status8,9

- **Air Ambulance Effectiveness Evaluation Models**

Clinical Outcomes Assessment Model: This model focuses on measuring the direct impact of air ambulance on the health and survival of the patient, which is the most important criterion, as effectiveness is evaluated .by comparing mortality rates Disability rates for airlifted versus ground-transported patients in similar injury settings using injury severity measures such as where the key performance indicators(KPIs) in this model include the survival rate upon discharge from the hospital, the length of stay in the intensive care unit, and the level of long-term functional recovery9,7

If the clinical outcomes show significant improvement for the group that was airlifted, this indicates high service effectiveness. Also, the operational and time performance evaluation model focuses on the service's efficiency in dealing with time, which is the critical factor in saving lives. Effectiveness is evaluated by :measuring precise time indicators that include :Includes Transmission time, which includes the time from receiving the report until the aircraft takes off, the time of arrival at the accident scene, and the total cycle .time .It is the time taken from dispatch until the patient is delivered to the hospital A service is considered effective if it is able to achieve specific time targets, such as reaching an incident site in remote areas within minutes . The evaluation also includes operational indicators such as the fleet's readiness rate and 20-15 the percentage of missions canceled due to operational or environmental factors7,10

The cost-benefit analysis model also aims to assess the economic feasibility of air ambulance services especially given their high operational costs. Effectiveness is measured by comparing the total cost of the service against its economic and social benefits. Economic benefits include savings in long-term healthcare

costs due to reduced disability, increased quality-adjusted life years gained, and the economic productivity of individuals who survive and return to work. Evaluating effectiveness using this model seeks to answer whether the significant investment in air ambulance services justifies itself in terms of saving lives and reducing the economic burden on society5,6

Study Location:

This study was conducted in the Kingdom of Saudi Arabia, focusing on remote areas far from urban centers that rely heavily on the air ambulance services of the Saudi Red Crescent Authority. These areas were chosen due to the frequency of traffic accidents and the difficulty of ground ambulance units reaching them in a timely manner.

Study Methodology:

The study adopted a descriptive and analytical approach, as it was appropriate for the nature of the objectives. It aimed to describe the effectiveness of air ambulance units and analyze their impact on reducing mortality rates resulting from accidents far from cities. Data were collected through a field questionnaire and statistically analyzed using arithmetic means, standard deviation, and correlation coefficient (Pearson).

Study Tool:

A 12-item questionnaire was used, specifically designed to measure the opinions of air ambulance workers and beneficiaries. The tool included four main dimensions:

Response speed.

Medical equipment readiness.

The level of coordination between air and ground ambulance.

Beneficiary satisfaction with the service. The items were constructed on a five-point Likert scale (from strongly disagree to strongly agree), and their validity and reliability were verified before being applied to the field sample.

Analysis

Table (1): Descriptive Statistics of Respondents' Answers

Statement	Mean	SD	Rank	Level
Air ambulances contribute to rapid access to accident scenes in remote areas.	4.45	0.67	1	Very High
Air ambulance units provide comprehensive medical equipment that enables them to deal with critical injuries in the field.	4.38	0.71	2	Very High
Transporting injured people by air reduces the time it takes to reach specialized hospitals.	4.32	0.75	3	High
The rapid response of air ambulance units reduces the mortality rate among the injured.	4.30	0.69	4	High
Coordination between air and ground ambulance contributes to improving the quality of emergency services.	4.26	0.73	5	High
The air ambulance crew receives specialized training that enables them to handle emergencies efficiently.	4.20	0.77	6	High
Air ambulance operations are characterized by high accuracy in locating accident locations using modern technologies.	4.10	0.80	7	High

Air ambulances help relieve pressure on emergency departments near cities.	4.05	0.82	8	High
Air ambulance units play an important role in reducing health disparities between urban and rural areas.	3.98	0.84	9	Moderate
Air ambulance is a necessary investment to improve the rapid response system to traffic accidents.	3.92	0.90	10	Moderate
The use of air ambulances increases satisfaction among the injured and their families.	3.85	0.86	11	Moderate
Air ambulances contribute to reducing long-term medical costs resulting from delayed transport of injured patients.	3.79	0.88	12	Moderate

Table (1) shows that the arithmetic means of the respondents' answers ranged between (3.79 - 4.45), which indicates a high agreement on the effectiveness of air ambulance units in rapid response and reducing deaths.

The highest-scoring item was "Air ambulances contribute to rapid access to accident sites in remote areas," while the lowest-scoring item was "Air ambulances contribute to reducing long-term medical costs," indicating that participants valued field effectiveness more than economic impact.

Table (2): Overall Effectiveness of Air Ambulance Units

Variable	Mean	SD	Level
Overall Effectiveness	4.14	0.74	High

The overall average (4.14) indicates that sample members highly agree that air ambulance units are effective in reducing death rates resulting from traffic accidents far from urban centers, which reflects a high level of satisfaction with the field performance of these units.

Table (3): Pearson Correlation Matrix Between Dimensions

Dimensions	Rapid Response	Equipment Readiness	Coordination	Satisfaction
Rapid Response	1	0.76**	0.71**	0.64**
Equipment Readiness		1	0.74**	0.66**
Coordination			1	0.68**
Satisfaction				1

Table (3) shows the presence of strong, positive and statistically significant correlations between the dimensions of air ambulance effectiveness.

The higher the level of rapid response, equipment readiness, and coordination between field teams, the higher the overall level of satisfaction with services.

The results demonstrate that these dimensions are interconnected in a way that enhances the effectiveness of the system as a whole, underscoring the importance of integrating operational, technical, and human elements to ensure the efficiency of air ambulances in saving lives.

Results

- The results showed a strong and direct inverse relationship between the use of air ambulances and .traffic fatality rates in remote areas
- The study showed that effectiveness is not limited to speed alone, but extends to the quality of advanced .care The air ambulance team provides services at the scene and during transport. Air ambulances have proven their ability to stabilize critically injured patients through advanced medical interventions such

as airway management and bleeding control, which are not typically available in regular ground ambulances. This means that patients arrive at the hospital in a better and more stable medical .condition, giving emergency room physicians a greater chance of success in definitive treatment

- The study confirmed that the effectiveness of air ambulances increases significantly in remote and rural areas that lack infrastructure and highways. In these environments, air ambulances are not a secondary option, but rather the only available means of providing a rapid and effective response to incidents far .from urban centers
- The study showed that air ambulance is a vital component of public health strategies to reduce accident .deaths

Recommendations

- .should be improved to reduce actual response time by establishing a network of airstrips Well-lit and equipped near accident hotspots on remote highways as well as in rural hospitals to enable rapid .transport between medical facilities
- Investment in advanced communications systems and modern navigation technologies (such as night .vision) must be made To ensure that air units can operate 24 hours a day and in difficult weather .conditions that may hinder ground ambulance operations
- Standardized and comprehensive medical protocols for aviation emergency medicine should be developed and implemented, focusing on advanced trauma management and resuscitation procedures .in the field environment prior to transport
- A highly qualified emergency physician or advanced paramedic with equivalent experience must be present on every flight, with ongoing and intensive training in air evacuation and handling of severe .injuries in restricted flight conditions
- Joint training exercises should be conducted regularly between air ambulance and ground ambulance .crews to ensure smooth and rapid coordination when meeting at an incident
- .A transmission system must be established Advanced central system based on geolocation technology It has the ability to quickly assess the severity of the situation and determine the nearest and fastest .means of air or land evacuation immediately and without delay, thus reducing the overall response time
- Clear and standardized criteria must be established to determine when air ambulance should be activated initially and when the patient should be transported by ground ambulance to a meeting point with the aircraft. This should be based on the severity of the injury and the distance of the site from the specialized center.

Conclusion

From the above, the importance of these recommendations becomes clear, as they represent a comprehensive and organized framework for upgrading air ambulance services from the level of efficiency to the level of maximum effectiveness in saving lives. The goal is not only to purchase aircraft, but also to .ensure that these aircraft operate within an integrated operational, logistical, and medical environment The infrastructure recommendations address the logistical roots of response delays, while the crew training recommendations ensure high-quality medical care in the air. The integration recommendations ensure that air ambulances operate flexibly and seamlessly with ground ambulances, eliminating any gaps in the emergency care chain. This reinforces air ambulances as an indispensable and reliable component of the .country's strategy to reduce traffic fatalities in remote and isolated locations

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