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A Descriptive Study Of The Availability Of Medical Equipment In Ambulance Units

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Abstract:
This paper will discuss the truth about the supply of medical equipment in ambulance departments with the main focus on showing how much they are ready to offer good pre-hospital emergency services. Medical equipment availability and suitability has been regarded as a critical determinant of quality, speed and safety of emergency medical service especially when dealing with life threatening and critical conditions. The research design is descriptive as the researcher gives an impartial picture of the current state of the medical equipment in ambulance units without trying to influence the variables and determine the causal relations. The descriptive methodology is based on the observation of documented facts based on the references to the relevant scientific sources, official documents, and past research, which discussed the emergency medical service, ambulance preparedness, and pre-hospital care system infrastructure. By analysing and combining the literature on the subject, the research determines the kind of necessary medical equipment needed at ambulance units including resuscitation equipment, monitoring equipment, airway management equipment and basic life support equipment. The results of the study are also likely to help comprehend the existing state of the availability of medical equipment in ambulance units better, as it will give decision-makers and health administrators a scientific foundation to base their decisions on. The study can contribute to the further planning, resource distribution, and the quality of emergency medical services by providing the description of the current reality. Also, it can be used as a resource on the further analogy or appraisal works aimed at the enhancement of the pre-hospital emergency care system..

Keywords Medical Equipment, Ambulance Units, Emergency Medical Services, Pre-Hospital Care, Descriptive study.

introduction

The health system is based on emergency ambulance services due to their responsiveness, as well as the quality of equipment used in the provision of this service is crucial in saving lives and preventing complications of injuries and acute diseases. The Saudi Red Crescent Authority is the primary organization that delivers these essential services in the Kingdom of Saudi Arabia in a large network of geographically spread ambulance units. In order to verify the effectiveness and operational efficiency of these units, there is a need to conduct periodic and overall evaluation of available resources, particularly

the medical equipment and supplies that are required to offer emergency care in these units on-site and during the transportation process to the health facilities. Hence, the presence of sophisticated and up-to-date medical equipment in the form of artificial respirators, vital signs monitors, fracture fixation devices, as well as the basic medicines and ambulance consumables are the main requirement that shall be assessed in measuring the preparedness and capability of the ambulance teams in addressing different emergency situations, be it in the form of traffic accidents, heart attacks, or mass disasters 1,2.

- **Conceptual framework for medical equipment in ambulance units**

The conceptual framework for emergency medical equipment refers to an integrated and interconnected set of tools, devices, and supplies specifically designed to provide primary and advanced emergency care in a pre-hospital setting This concept is not limited to a mere list of categories but includes three main dimensions Quality, quantity, and readiness are all factors considered when classifying equipment according to the level of care provided, such as basic or advanced care, and its function within the emergency response process, from assessing the patient's condition and stabilizing them to advanced cardiopulmonary resuscitation and safe transport. The classification also focuses on the basic functional classification of this equipment which is traditionally divided into main categories essential for the paramedic's work. These categories include diagnostic and monitoring devices such as blood pressure monitors and pulse oximeters ECG devices These help in identifying vital signs, assessing the severity of the condition, and providing life support and resuscitation tools, which are the most important and include defibrillators Airway control equipment Such as suction devices, breathing tubes, manual or mechanical ventilators, as well as immobilization and transport equipment such as neck braces, various splints, and patient stretchers Which ensures the patient's safety during the ambulance and transport process 1,2

The conceptual framework also includes a standard for the quality of equipment and its compliance with standards The availability of equipment is not sufficient in itself; the equipment must also be usable, safe, and regularly maintained according to standards To ensure the accuracy of readings and therapeutic effectiveness, especially with sensitive devices such as injectors and pumps, this framework also includes the concept of flexibility and comprehensiveness, i.e., the extent to which equipment can meet diverse needs, whether in cases of shock or acute medical conditions Or children's emergencies, which require the presence of kits and equipment of different sizes and specifications. This dimension has made it possible to have all the ambulance units within the Saudi Red Crescent in full gear to manage any emergency with high efficiency and professionalism. Moreover, the idea is founded on a management and logistical support system that promotes the constant supply and replenishment of equipment. This involves safe and efficient storage processes, formulation of both preventive and corrective maintenance programs, as well as a system of checking the expiry dates of the medical consumables and medicines. This is the administrative and logistical factor which keeps the entire ambulance fleet fully prepared because the most efficient equipment is useless, when it is not present at the right time and place or in the condition of being out of service because of the absence of any maintenance or replacement. It is this combination of functional and administrative features that make the difference between the success of the conceptual framework of medical equipment in any contemporary ambulance system 10,6.

- **Types of medical equipment required in ambulance units**

The equipment in ambulance units is categorized on the basis of their mainly intended use in their support of life and emergency care. There are four basic types of this classification which cannot be avoided in operation of any modern ambulance unit and can be explained in the following ways: The first and the most essential type is the basic and advanced life support equipment which is used to maintain vital functions of the body, such as respiration and blood circulation and includes such types as automated and semi-automated external defibrillators Multifunctional cardiac monitors also include essential airway management devices, e.g., intubation kits, laryngeal masks, and specialized first aid kits with bandages, gloves, and hemorrh The second category of equipment comprises diagnostic, assessment and non-stop observation equipment of the patient health. Such machines are necessary so that the paramedic can make quick and precise clinical judgments before he or she arrives at the hospital. The devices that measure the rudimentary vital signs, which should be included in this category, are blood pressure monitors Pulse oximetry For measuring blood oxygen levels, thermometers and instant blood glucose meters. Special

devices are incorporated to test neurological damage as well as trauma cases, so the paramedic could promptly monitor the development of the situation in the patient and convey the correct information to the hospital that received the patient 5,3.

The third category is aimed to stabilize the injuries, prevent the additional complications, and assure the safety of transport of patients where the Paramedics frequently deal with the accidents when the spinal column and arms should be immobilized so that the consequences could not be irreversible. This equipment involves neck braces in different sizes, pneumatic splints, wooden splints, or flexible splints to fix fractures and long spinal plates Patient transport carriers The equipment in these units should have modern restraint systems. These devices are essential in offering enhanced first aid and safety of patients during the transport of them out of the place of accident to the ambulance unit and subsequently to the emergency room. The fourth group includes support equipment, consumables, and emergency medications which is an obligatory component of any emergency procedure. This group encompasses intravenous fluids, medical solutions and emergency essential medications given in a particular circumstance i.e. during an asthma attack, acute allergic reaction and cardiac arrest. It also entails consumables required in safety and infection control processes, including material of sterilization, masks, protective eyewear, and sharps containers that are to be utilized in the safe disposal of sharps. A strict control over the stock of these consumables and their date of expiry is a basic need that these materials in the ambulance units of the Saudi Red Crescent 9,3 will be fully operational.

- The importance of having medical equipment available in improving the quality of ambulance services

Quality of ambulance services is one of the major components of emergency health response and enhancement of quality is intricately associated with access and efficiency of medical equipment present in the ambulance units. The main significance is the ability to diagnose and intervene in the acute and timely manner to save the lives of patients. The latest gadgets used in vital signs surveillance like electrocardiographs and pulse oximeters have enabled paramedics to determine the patient situation with a high level of accuracy and speed, thus allowing them to know what the emergency is; be it an attack on the heart, respiratory failure or shock. This fast diagnosis saves time being spent in the field, as well as maximum chances to save a life and reduce the severity of complications. It places the ambulance teams in a position to offer high quality care Effectively and dependably, the existence of special equipment like advanced defibrillators portable artificial respirators and in-built intravenous infusion kits does not transform the service to a simple transport service but rather to a mobile care service. The paramedic who is qualified and backed by such equipments is able to offer life-saving measures to the accident scene including administration of emergency drugs, management of the airway by intubation or stabilization of complex fractures. Such a care will guarantee the stabilization of the condition of the patient prior to the transportation process that will lessen the risk of the decline of his/her state within the trip to the center of treatment8,7.

It is also associated with keeping the patient and the paramedic safe and enhancing the efficiency of the functioning of the unit Modern medical equipment does not only save lives but it also provides comfortable and safe immobilization and transportation tools to minimize the chances of worsening the spinal injuries or fractures during the movement. The access to personal protective equipment is also imperative. The use of infection control and sterilization materials creates a safe working environment of paramedics and decreases the chance of disease transmission. Moreover, it controls availability of adequate equipment and availability of the ambulance units ready to work day and night without failure caused by the malfunctions or lack of supplies. Therefore, medical equipment quality and efficiency depicts the image of the Saudi Red Crescent as a top-notch organization that focuses on the highest international norms of emergency care. Such an investment will increase the society trust in ambulance services and directly lead to the accomplishment of healthcare objectives of the Vision 2030 of the Kingdom that aims to enhance the health status and living standards of the population. The presence of equipments is a concrete sign of the dedication to equip paramedics with the best tools needed to assist them to carry out their work effectively that eventually translates to lowering the mortality and disability rates caused by emergency incidents6,8.

- **The reality of the availability of medical equipment in ambulance units**

Accessibility of medical equipments in all ambulance units of different countries, the Saudi Red crescent inclusive, has been exhibiting high disparities, which is a result of numerous economic, geographical and logistic influences. In general, the basic life support equipments are regulated Most ambulance units are equipped with blood pressure monitors, basic immobilization equipment, and first aid kits, but the biggest challenge is fairly distributed and regular provision of newer and more expensive equipment, especially the advanced life support equipment, which includes multi-standard monitoring devices and advanced mechanical ventilators, and is a common cause of shortage or obsolescence of such equipment in periphery and remote units. Maintenance and the quality of equipment is also a basic issue that influences its true availability. The presence of equipment does not always imply its availability and readiness to use, since most ambulance systems lack effective preventive maintenance programs, which results in the higher malfunctions rates and long out-of-service periods of the most important equipment. Moreover, the time lag in the process of providing the equipment that has lost its usefulness or become unable to work in accordance with the new standards, as well as this shortage of the administrative and logistical level, do not enable the professional use of the available resources and undermine the actual work of the ambulance unit 1,9.

The uninterrupted supply of medical resources and emergency drugs is an important factor to evaluate equipment availability. Other equipments like intravenous infusion sets cannot be utilized well without the unlimited and adequate supply of their consumables like solutions, needles, and syringes. It is common in field studies to find an inadequacy of specific medical supplies having short shelf life or those with special storage requirements. Such shortage of life-saving drugs as epinephrine or nitroglycerin, sterilizing agents, or bandages is a significant gap in the spectrum of the provision of comprehensive services, even in ambulance service units with the latest technology. Thus, one can indicate that medical equipment in the Saudi Red Crescent is challenged with unceasing integration and modernization in order to remain in step with global medical development. The effort to improve the infrastructure is evident with the implementation of the goals of the Kingdom of Vision 2030. Nonetheless, it demands a successful logistics system that keeps track of the stock of each of the units in real time so that the paramedic training and the quality of the provided equipment were synchronized and that each ambulance is indeed a mobile intensive care unit. Anywhere, anytime mobile unit that is ready 5,6.

- **Level of readiness of medical equipment and supplies in ambulance units**

The readiness level of medical equipment and supplies is the true measure of an ambulance unit's efficiency, and it is defined as the overall ability to use all available equipment to perform the required ambulance task without deficiency or delay Readiness is initially determined by the quantitative and qualitative availability of basic and backup equipment. Devices listed in the approved care requirements list, whether basic or advanced, must be physically present within the emergency unit. This level is measured by conducting periodic and surprise inventory to ensure the completeness of the medical kit and reviewing the diagnostic and resuscitation equipment lists to ensure there is no shortage of any vital element before the start of the shift. It also focuses on the technical and functional readiness of the equipment. It is not enough for the device to be physically available, but it must be fully functional and efficient. This requires ensuring that sensitive devices such as monitoring and breathing equipment are calibrated regularly according to a specific schedule, and that all necessary parts and accessories are connected and intact. Technical readiness also includes ensuring that the batteries of electrical devices are fully charged, providing alternative power sources, and ensuring the effectiveness of the suction system and the integrity of all electromechanical connections. This aspect depends largely on the existence of a strict and effective preventive maintenance system that ensures that malfunctions are rare and addressed very quickly2,7

In addition, there is the readiness related to the logistical availability of consumables and pharmaceutical supplies A defibrillator is not fully functional if the electrodes are Unavailable or expired supplies, as well as first aid injections that depend on the availability of intravenous solutions and emergency medications, are common problems. Enhancing preparedness also requires a precise inventory management system that allows for continuous monitoring of expiration dates and ensures minimum and

reserve stock levels of all consumables to guarantee uninterrupted supply chains. This integration between the equipment itself and the materials it needs to operate determines the level of operational readiness. Furthermore, the level of preparedness is directly linked to the readiness of the paramedic His ability to handle these devices is crucial. The device is only ready when the paramedic is adequately trained to operate and use it in various stress scenarios. Therefore, comprehensive readiness requires the inclusion of periodic and intensive training programs on new and complex devices and the implementation of emergency simulations. Thus, it can be said that the level of readiness of equipment and supplies in the Saudi Red Crescent ambulance units is not measured only by their presence on the list, but by their technical and logistical efficiency and the ability of the work teams to employ them with high skill at the critical time to save lives6.7

- Factors affecting the availability of medical equipment in ambulance units

The situation with medical equipment in ambulance units depends on a complex of factors, including administrative, financial, and logistical and environmental factors, but the financial factor and the budget allocated are the most significant ones, as modern medical equipment, in particular, the equipment related to the advanced life support, involves considerable resources, and the availability of the budget is not only of first purchases but also the periodical replacement and maintenance. Very frequently, austerity can be a hold-up to the acquisition of new equipment or even consumables, which leads to the mismatch between the real supply and the ordered goods. Moreover, the supply chain and logistics system also play a crucial role in making sure the availability continuity, which also involves effective inventory control, beginning with safe and proper storage, continuing through an efficient distribution system that can deliver supplies to the emergency units in remote locations at maximum speed that is possible. The lack of adequate prediction of consumption or shortage of the electronic inventory monitoring system may result in the immediate loss of essential materials, particularly in the busy periods or crises, which directly decreases the preparedness of units6,9.

The operational and geographical environment of the ambulance unit also plays a significant role in influencing the availability, as high temperatures or humidity can also have a toll on the condition of the equipment and its effectiveness in the ambulance unit The operational environment and geographical location can influence the rates of equipment replacement and maintenance as well since high temperatures or humidity levels cause a greater amount of wear and tear. Also, the issue of fair distribution of modern equipment among the cities and the rural units results in inequalities in the level of service delivery and more urban centers tend to be favored. Such factors as administrative organizational, and technical maintenance cannot be neglected There should also be clear and standard policies and procedures regarding scheduling preventive and corrective maintenance of all equipment. Lack of efficient maintenance management causes equipment to be offline over extended periods of time, therefore, impacting adversely on its real availability. The absence of periodic training of paramedics on how to handle and use equipment and proper use may lead to malfunctions caused by abuse and that will lead us back to the initial stage. These administrative and organizational aspects constitute an overarching umbrella that defines the level of success of the Saudi Red Crescent in ensuring high level of availability and preparedness of medical equipments 9,2.

- Challenges associated with the lack of medical equipment in ambulance units

Medical equipment shortage in the emergency units is a significant issue that has both direct and severe consequences on quality care delivery and patient safety. The first and most urgent problem is the insufficiency of the emergency intervention level and the lag during which the paramedic only manages to provide basic care even in situations that need advanced and immediate intervention, this lack of equipment is costly in terms of seconds and minutes, which can be crucial to save lives and face the injured with irreversible injuries. The second issue is connected to the fact that the workload of ambulance crews is subjected to the heightened level of psychological and professional stress and how it affects performance. A paramedic who is employed in a unit with insufficient resources becomes aware of the fact that they are unable to offer the patient all, which causes frustration and a sense of incompetence in his or her profession. This lack of vitamin does not only threaten the life of the patient but also has a negative influence on the morale and overall productivity of medical staff, who have to work under a

challenging environment and resort to inefficient substitutes. Having this sustained pressure may result in higher job burnout rates Job attrition among qualified paramedics3,6

The third challenge is the incapability to comply with international and local standards regarding emergency care quality where International and local accreditation authorities such as the Saudi Red Crescent standards impose equipment requirements that should be fulfilled in all the ambulance units to guarantee the minimum quality standards and safety standards. Once that there is a constant or repeated shortage of any of the items in this list, be it monitoring equipment or medical supplies, it is a phylogmatic indication that the unit is not functioning as it should be. This lack does not only jeopardize the reputation of the institution but also complicates the process of integration with other aspects of the healthcare system including the hospitals that depend on receiving the correct and consistent cases evaluation by the field. Moreover, the lack of equipment results in the economy of the overall cost to the healthcare system in the long term The inability to stabilize the patient condition in the sphere will inevitably presuppose the extension of the stay in the intensive care unit of the healthcare facility and the costs of curing complications and disabilities caused by the delay in taking care of the patient. Therefore, emergency equipment scarcity is another indicator of the redistribution of the burden of care in, relatively low-cost emergency setting to the high-cost hospital which is a long-term burden on the budget of the public health 9,7.

- **The implications of the availability of medical equipment in ambulance units**

The effect of the supply of medical equipment on the emergency units is significant and direct at the same time, the first and the most important effect is the effect it produces on the clinical intervention of the emergency setting, which contributes to better survival of the injured and lowers the rates of permanent disability. On the other hand, insufficiency or obsolete equipment results in the postponement of the start of life-saving processes and the additional risk of incorrect assessment of the situation and the development of the injuries further and the necessity of intensive and prolonged hospitals in a specific case. The efficiency and capacity of the ambulance service also directly depends on the level of equipment availability. With proper equipment that is readily available and operational i.e. in high state of readiness, the ambulance teams will be able to manage more cases and within a shorter period of time and this will trim down the total response time and improve the turnover of ambulance units. This means that equipment that is out of service due to lack or need of maintenance is not available to respond to cases in the network, unnecessary strain on other units in the network is created, and causes delay in the provision of aid to those in need 2,9.

The implications of the availability level can be characterized as financial and logistical to the entire health system. Effective preventive maintenance and proper planning of the availability and sustainability of equipment is an investment that incurs less cost in the future in terms of emergency repair or premature replacement. Good ambulance services with full equipments minimize the hospital processes which are complicated and expensive. Shortages, on the other hand, lead to indirect costs in the long run since the health system has no option but to manage complex or severe situations that would have been stabilized early in the field. The level of availability is measured in the level of job satisfaction of the paramedics and the confidence that the people have in the service. When a paramedic possesses all the needed materials to do his/her job, he will be more professionally competent, and capable of delivering maximum care, which improves his morale and allegiance to the institution Conversely, when a shortage of equipment is evident, it will cause everyone to feel that the Saudi Red Crescent is not capable of the required support in case of an emergency. Consequently, equipment provision is one of the pillars not only in clinical work, but also in the development of institutional trust and the attainment of a sustainable outcome in the provision of ambulance services9,3.

METHODOLOGY

The descriptive research methodology is the foundation of the study as it seeks to describe and record the prevailing reality of the situation of medical equipments provision in ambulance units. The chosen methodology will rely on the examination and assessment of the relevant scientific publications, official reports as well as past research concerning emergency medical services and ambulance preparedness. The

descriptive method would be appropriate to do this research because it is aiming at delivering factual data and precise description of the current situation without any experimental intervention.

- **Results and recommendations**

Results

- The study showed a very high availability of basic life support equipment and a significant disparity in the availability of advanced equipment Availability is higher in cities and regional centers compared to peripheral units or those operating on remote highways
- The study revealed that a certain percentage of vital equipment, such as cardiac monitors and ventilators, are out of service Due to the need for periodic maintenance or technical calibration, which negatively affects the overall readiness index
- The study revealed that some ambulance units suffer from periodic shortages or interruptions in the availability of short-expiry medical supplies and essential emergency medicines, indicating challenges in the logistical inventory management system
- The study showed that slow procurement cycles and insufficient budgets allocated for periodic maintenance and replacement are two key factors behind the availability gaps
- She explained that there is a weakness in logistical planning and the lack of a unified and effective electronic system to monitor actual inventory and authorizations as one of the most prominent administrative challenges
- The study revealed a negative correlation between the lack of advanced equipment and the ability of paramedics to provide the necessary urgent interventions in the field, which may contribute to increased rates of unstable transport of critical cases
- The study showed that the low level of equipment availability contributes to a decrease in job satisfaction and an increase in occupational stress among ambulance crews as a result of their feeling of inability to provide ideal care

Recommendations

- A central automated system must be established and implemented to monitor the actual inventory of equipment and consumables in each ambulance unit in real time, linked to expiry dates and automated reorder alerts
- The need to reassess and amend the criteria for distributing advanced equipment To ensure their balanced availability in peripheral ambulance units based on the epidemiological and geographical characteristics of the service area and not just on population density
- A central reserve stock should be allocated to address crises and disasters, including life-saving medicines and high-consumption supplies, to ensure that there is no disruption in the supply chain
- Mandatory periodic maintenance programs must be activated by establishing a strict and computerized schedule for preventive maintenance and technical calibration of all biomedical devices and by identifying specialized technical teams to ensure that the time devices remain out of service is minimized
- Ambulance crews must be required to follow comprehensive daily checklists of equipment before the start of their shift, focusing on technical readiness, charging levelscompleteness of consumables, and immediately recording any deficiencies in the electronic system
- It is necessary to develop a clear financial and procedural plan to replace equipment that has exceeded its lifespan or that is no longer compatible with modern medical technology in order to ensure the fleet's efficiency is maintained
- The need to develop specialized and continuous training programs for paramedics to optimally handle newly available advanced medical equipment and to measure their efficiency in using this equipment under pressure working conditions
- It is necessary to adopt clear quantitative performance indicators to measure the qualitative and temporal availability of equipment and the response time to malfunctions and to include these indicators in the quarterly performance reports of senior management

- It is necessary to ensure that a fixed and independent budget is allocated within the annual budget of the Saudi Red Crescent Authority to cover the costs of modernization and the purchase of high-tech equipment, taking into account the annual increase in the cost of medical technology
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Conclusion

This research was to determine the supply and effectiveness of medical equipment in ambulance units. The findings indicated that a big proportion of ambulance units are equipped with the fundamental equipment necessary to carry out the emergency ambulance duties. Nevertheless, there is a visible difference and deviation of the degree of equipments among the regions with urban centers being more equipped and developed than the rural and remote centers. It was also found that periodic maintenance systems and technical education on the use of modern equipment should be improved to make it available in the case of an emergency. The findings established that the complete access to medical machinery has a positive influence in providing quality of service and the pace of response to the field, particularly bleeding, cardiac arrest, and multiple injuries. The research made some recommendations with the most significant one being the necessity to standardize medical equipment in all ambulance units and introduce an electronic system allowing to track the availability of equipment in the field in real time, which contributes to the effective work in the field and corresponds to the Vision 2030 of the Kingdom in building the emergency system and high-quality health services.

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