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Assessment of EMS Providers' Competencies in Managing Cardiac Emergencies in Saudi Arabia: A Comparative Study with International Standards

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ABSTRACT

In cases of cardiac arrest, efficient cardiopulmonary resuscitation (CPR) is essential to improve prognoses. The purpose of this study is to evaluate the level of CPR competency among paramedics in Saudi Arabia, with an emphasis on compression depth and ventilation procedures. In this investigation, 69 paramedics participated,

and CPR scenarios were simulated on an Ambu manikin. With an emphasis on the accuracy and effectiveness of breathing procedures as well as the constancy of compression depth, this configuration made it possible to thoroughly evaluate each participant's approach. According to the study, paramedics performed chest compressions with impressive skill, averaging 58.48 mm, which is within the recommended range of 50 to 60 mm. The compression depths did, however, differ substantially, ranging from 47 mm to 72 mm. Furthermore, there were notable discrepancies in the ventilation methods, with 87.4% of ventilations being carried out below the suggested volume limit. More participants' deviations from the recommended compression-to-ventilation ratio highlight the need for stricter adherence to the standards. Although paramedics have a solid foundation in CPR, there are noticeable variances and anomalies that highlight the need for ongoing, targeted training. To remedy these gaps, this report recommends creating and implementing focused training initiatives. To enhance overall CPR performance and subsequently improve patient outcomes in emergencies, such programs should prioritize adherence to established CPR recommendations and highlight the integration of realistic simulation experiences.

Keywords: CPR, Paramedic, Emergency medical services.

Introduction

According to data from the literature currently in publication, diabetes mellitus and cardiovascular disease (CVD) are major risk factors for MEs and have significant incidence rates in Saudi Arabian society (Sheikho et al., 2018). An estimated 3,50,000 to 700,000 people experience "sudden cardiac arrest" each year, according to a study conducted in Europe (Jodalli & Ankola, 2012; Sopka et al., 2012). Approximately 17.3 million deaths worldwide are attributed to CVD each year. Common abnormalities of the acute cardiovascular system include angina pectoris, myocardial infarction (MI), heart failure, and hypertensive crisis.

To restore breathing and blood circulation after a cardiac arrest, cardiopulmonary resuscitation (CPR) is an emergency non-invasive procedure that combines chest compression and artificial respiration provided by mouth-to-mouth ventilation (Lee, 2012). Heart arrest is a prevalent ailment in both industrialized and underdeveloped nations (Rao, 2014). In the World Journal of Emergency Medicine, the majority of cardiac arrest cases (92.5%) took place in the home (Krishna et al., 2017). Because cardiac arrest is an emergency, prompt medical attention is necessary. The most crucial medical intervention in cases of cardiac arrest is CPR. In several Asian nations, ambulance personnel handle out-of-hospital cardiac arrests (OHCAs) on a regular basis before they are transported to hospitals. They give the sufferers prompt CPR (Hock Ong et al., 2013). American Heart Association guidelines from 2015 state that ambulance service members should be trained to provide urgent CPR on a victim on the spot. The mortality and morbidity of cardiac arrest are directly correlated with the time delay in starting CPR, as it is most effective when done immediately after the arrest. By maintaining a dynamic blood flow, prompt CPR administered by the ambulance team can increase the chances of survival after cardiac arrest and increase the likelihood of a successful recovery (Neumar et al., 2015).

Providing patients with emergency assistance requires effective ambulance care (Institute of Medicine (US) Committee on Guidance for Establishing Standards of Care for Use in Disaster Situations, 2009). It is proposed that emergency medical personnel should be prepared to perform CPR when necessary, and that ambulances should be fully furnished with emergency gear to enable the provision of emergency medical care.

Sudden Cardiac Arrest (SCA) is still a difficult problem. Because SCA is so common and is one of the top causes of death, taking many lives year, it is extremely important. The pre-hospital survival rates of SCA victims are startlingly low, with discharge rates ranging from about 3% to 25%, despite notable improvements in medical response capabilities (Allan et al., 2023; Malik et al., 2022). This alarming number emphasizes how urgently better emergency interventions are needed, especially in the critical minutes that follow an arrest before help arrives from a competent source.

Since cardiac arrest is the most frequent cause of deaths that occur outside of hospitals, basic life support (BLS) becomes crucial to the survival of cardiac arrest victims. The ambulance crew is always the first to respond in the event of an out-of-hospital cardiac arrest, and the patient may suffer grave consequences if they take too long to get to a medical facility. In an emergency like this, first responders and paramedics are on the front lines. The incapacity to do CPR poses a serious threat to the health care system of any country (Graham et al., 2015). Promoting survival rates in SCA cases is largely dependent on the prompt start and efficacious performance of cardiopulmonary resuscitation (CPR). Professional CPR, defined as competent chest compressions and sufficient breathing, is recognized by eminent medical associations like the American Heart Association (AHA) and the European Resuscitation Council (ERC) as the cornerstone of successful emergency cardiac treatment (Considine et al., 2020; Semeraro et al., 2021). With their advanced resuscitation equipment and specific training, the EMS crews are vital in this crucial intervention, frequently determining the difference between life and death (Gässler et al., 2022; Lott et al., 2021).

For SCA patients, the change from expert medical assistance to CPR performed by bystanders is a crucial point in the survival chain. The significance of paramedics in the Polish Emergency Medical Services (EMS) system is emphasized by this phase. Paramedics have a crucial role in SCA circumstances since, in Saudi Arabia, they are frequently the first medical personnel to interact with patients in emergency situations. They must quickly assess the situation, start advanced life support, and make sure that bystanders who have started high-quality care continue to provide it.

Polish paramedics, however, confront a variety of special difficulties in carrying out their work, from negotiating the intricacies of emergency scenes to operating under intense pressure during SCA crises. Patient outcomes are directly impacted by the paramedics' effectiveness and amount of engagement in these situations. Thus, it is essential to comprehend the subtleties of their responsibilities, difficulties, and emergency care standards to assess and improve SCA response techniques.

Time is a critical component for the victim's endurance during cardiac arrest. Giving the sufferer high-quality resuscitation care during the so-called "golden period" can have a direct impact on their chances of life. Therefore, the ambulance team is responsible for performing BLS on behalf of the patient experiencing cardiac arrest. Poor knowledge of CPR among ambulance workers in India has an impact on patient morbidity and death (Bansal et al., 2016). The effectiveness of emergency response care performance is diminished by the inadequate emergency ambulance equipment. CPR training is a crucial component for ambulance personnel. To provide patients with emergency care, ambulance personnel must be proficient, courteous, resourceful, and professional. Consequently, the goal of the current study was to evaluate the staff members' understanding of CPR, the state of the ambulances' equipment, and how they used it for CPR or first aid.

Saudi Arabian paramedics receive extensive training in both theory and practice to provide them the tools they need for critical medical situations. This training follows both national and international standards and includes a range of programs from basic emergency care to advanced resuscitation techniques. Their length of service, credentials, and most recent improvements to their training regimens demonstrate a continuous dedication to enhancing Saudi Arabia's emergency medical response capacities. But it's crucial to look at how this instruction is used in real life, especially when performing CPR.

Paramedics in Saudi Arabia assess CPR performance based on norms and protocols that meet both worldwide best practices and national requirements (Gässler et al., 2022). These guidelines are intended to guarantee that CPR is administered successfully and efficiently, increasing the likelihood that SCA patients will survive (Gianni et al., 2024). Current guidelines emphasize the necessity for emergency medical professionals to continuously learn and adapt as best practices for resuscitation procedures evolve (Danış & Kudu, 2022)

There is still a knowledge gap about the real-world CPR practices of Saudi Arabian paramedics, even with these strict training and assessment programs. There are still unanswered questions regarding how closely their practices adhere to set standards and where their training could be improved. This gap indicates a need for more research in this important area and suggests that CPR outcomes could be significantly improved.

The study that is being presented here aims to directly answer these questions. The purpose of this study is to identify the advantages and disadvantages of Saudi Arabian paramedics' current CPR performance. The goal is to pinpoint specific procedural and training deficiencies that, if filled, could result in a noticeable increase in the standard of CPR provided in an emergency.

The dynamic nature of medical emergencies and the ongoing breakthroughs in resuscitation research make this investigation both necessary and timely. This study attempts to integrate the theoretical knowledge gained during training with the practical implementation of CPR techniques in emergency situations by evaluating the

present level of CPR performance among Saudi Arabian paramedics. The improvement of patient outcomes in SCA settings and the effectiveness of emergency medical care ultimately depend on this alignment.

This groundbreaking study adds to the international conversation on emergency medical care and offers insightful information unique to the Saudi Arabian setting. The study aims to raise awareness and enhance emergency medical response standards in Saudi Arabia by identifying possible areas for improvement in CPR instruction and performance. The goal of this project is to improve EMS teams' preparedness and effectiveness.

Research Questions:

- What is the current level of CPR competency among paramedics in Saudi Arabia, specifically in terms of compression depth and ventilation procedures?
- What is the current level of CPR competency among paramedics in Saudi Arabia, specifically in terms of frequency and volume of ventilations?
- What is the level of compliance with international CPR guidelines among paramedics in the Red Crescent Authority, Makkah Al-Mukarramah?

Research Objectives:

- To determine the current level of CPR competency among paramedics in Saudi Arabia, specifically in terms of compression depth and ventilation procedures.
- To determine the current level of CPR competency among paramedics in Saudi Arabia, specifically in terms of frequency and volume of ventilations.
- To determine the level of compliance with international CPR guidelines among paramedics in the Red Crescent Authority, Makkah Al-Mukarramah.

Methods

Settings and participants

The current study community consists of the paramedics working for the Red Crescent Authority in the Makkah Al-Mukarramah region in the Kingdom of Saudi Arabia.

The origin of scientific research is to be conducted on all members of the research community; because this is more likely to confirm the results, but the researcher resorts to choosing a sample of them if this is not possible due to their large number, for example" (Al-Assaf, 2003, p. 96); therefore, the researcher chose a random sample, where the sample amounted to (69) paramedics working for the Red Crescent Authority in the Makkah Al-Mukarramah region in the Kingdom of Saudi Arabia.

Targeting 69 paramedics from the Saudi Arabia, the study was started in 2018. This cohort was specifically selected to enable a thorough and in-depth examination of their fundamental life-saving intervention abilities. The selection procedure was optional and anonymous to encourage open communication and sincere performance. The participants offered a diversified viewpoint on emergency medical

practices because they were active medical rescuers working in a variety of emergency contexts, including air ambulance services, hospital emergency departments, and medical rescue teams.

Selection process

The study's selection procedure was carefully planned to guarantee a representative and varied sample of paramedics from Saudi Arabia. To promote an atmosphere of integrity and openness, participants were gathered via an open call within the EMS community, with a focus on voluntary and anonymous involvement. The goal of this strategy was to entice Medical Rescuers from a variety of emergency response contexts to take part. Providing specifics about this procedure demonstrates our dedication to diversity and our search for thorough knowledge about CPR competence in emergency medical services.

Data collection

The CPR proficiency of the trainees was assessed largely through the practical training sessions that were held. The Ambu Man manikin, which is outfitted with advanced software for analysing CPR effectiveness, was used by participants in drills that replicated actual emergency situations. All the participants had never used this hands-on method before, yet it was essential for evaluating their proficiency in life-saving measures, particularly chest compression and breathing methods. Because of the manikin's sophisticated capabilities, it was possible to accurately assess each participant's compliance with CPR recommendations, facilitating the transfer of theoretical knowledge to real-world scenarios.

Study Limitations

Although the 69- From the worker in the Saudi Red Crescent Authority in the Makkah Al-Mukarramah region, sample size was sufficient for a thorough initial study, there are issues with the findings' wider application. Furthermore, the results of the study can be impacted using Ambu Man manikins and the usual 6-minute CPR exercises, which may not account for the unpredictability of real-life emergency situations.

- Geographical limitations: The study will be conducted in the Kingdom of Saudi Arabia.
- Time limitations: The study will be conducted in 2024.
- Subject limitations: The study is limited to investigating EMS Providers' Competencies in Managing Cardiac Emergencies in Saudi Arabia.

Statistical analysis

Microsoft Excel software was used for data compilation and early analysis (MS Office 2016, Redmond, WA, USA). Utilizing Statistica 13.1 (StatSoft Polska, Tulsa, OK, USA) for advanced statistical analysis, quantitative data was presented using a variety of statistical measures. A Shapiro-Wilk normality test was also used in the study to evaluate the variable distribution.

Results

Demographics and professional background of participants

The 69 paramedics in this study, whose ages ranged from 29 to 59 years old with an average age of 40 years, were primarily male (97.10%) and used CPR procedures. The volunteers' large age range is not as representative of their CPR experience as the length of service, which ranged from 7 to 36 years with an average of 17.74 years. The range of experience in emergency medical services shown by this difference in service time ranges from highly experienced professionals to paramedics who are very new to the field. The bulk of the study participants worked in conditions that were identical to one another, which limited the diversity of job settings. Nevertheless, the range of service years offers important insights into how experience affects CPR performance.

Table 1 Characteristics of the study group (n = 69).

Characteristic	Detail	Statistics
Gender		
	Men	67 (97.10%)
	Women	2 (2.90%)
	Mean (M)	40.33
	Standard Deviation (SD)	7.05
	Median (Me)	38.00
	Quartiles (Q1–Q3)	36.00–44.00
	Range (Min–Max)	29.00–59.00
Length of Service (yr)		
	Mean (M)	17.74
	Standard Deviation (SD)	6.96
	Median (Me)	16.00
	Quartiles (Q1–Q3)	12.00–21.00
	Range (Min–Max)	7.00–36.00
Place of Employment		
	Emergency Medical Services Team	66 (95.65%)
	Air Ambulance Service	1 (1.45%)
	Hospital Emergency Department	9 (10.47%)
	Emergency Call Centre	9 (10.47%)
	Reception Area	1 (1.16%)

CPR performance analysis

We assessed the depth and frequency of chest compressions as well as the frequency and volume of ventilations in our thorough examination of paramedics' performance in CPR. We found that the average ventilation volume was 0.36 liters and the average ventilation rate was 4.51 breaths per minute. This result, particularly the rate of 4.51 breaths per minute, raises significant questions about how well it aligns

with the most recent CPR recommendations, which call for a cautious strategy to guarantee sufficient oxygenation without sacrificing the effectiveness of chest compressions. The fluctuations observed in our data highlight the necessity of continuous assessment and updating training materials to stress the vital harmony between chest compression methods and ventilation frequency. These changes will help paramedics do CPR as effectively as possible, especially when using bag and mask ventilation, which is one technique we concentrated on because it is frequently utilized in emergency situations.

After examining the data related to chest compressions, we discovered that the median rate was 118 compressions per minute, which is in general consistent with the suggested range of 100 to 120 compressions per minute. Nonetheless, a wide range of practice approaches is shown by the observed variability, which ranges from 87 to 146 compressions per minute and compression depths between 47 mm and 72 mm. These results underline how important it is to have regular, standardized training to promote adherence to CPR recommendations and guarantee efficient and reliable CPR delivery.

Considering the current CPR guidelines, which generally advise a more controlled rate to optimize patient outcomes, a closer examination of the variability in ventilation rates is necessary, particularly regarding the average rate of 4.51 breaths per minute. Our findings imply that even experienced paramedics might benefit from updated, evidence-based training sessions that address these differences, raising significant questions about the present training and practice standards. It will be crucial to examine current research and CPR guideline revisions to comprehend these variations and modify training regimens appropriately. It is obvious that training techniques need to be revised to better fit with current guidelines and developing research, given the heterogeneity in CPR performance as presented in Table 2. The range of competency seen emphasizes this need, supporting a strategy that customizes training to the complex requirements of emergency responders.

Table 2. Detailed ventilation and chest compression parameters.

Parameter	n	Mean (M)	Standard Deviation (SD)	Median (Me)	Quartiles (Q1–Q3)	Range (Min–Max)	Shapiro-Wilk (S-W)	Significance (*p*)
Minute Ventilations (liters/min)	69	1.79	1.02	1.80	1.00–2.50	0.00–4.00	0.967	0.0680
Ventilation Rate (breaths/min)	69	4.51	1.77	5.00	3.00–6.00	0.00–7.00	0.879	<0.0001
Ventilation Volume (liters)	69	0.36	0.14	0.40	0.30–0.40	0.00–0.70	0.940	0.0020

Parameter	n	Mean (M)	Standard Deviation (SD)	Median (Me)	Quartiles (Q1–Q3)	Range (Min–Max)	Shapiro-Wilk (S-W)	Significance (*p*)
Rate of Chest Compressions (compressions/min)	69	116.70	11.05	118.00	110.00–124.00	87.00–146.00	0.989	0.8020
Chest Compression Depth (mm)	69	58.48	5.75	58.00	54.00–62.00	47.00–72.00	0.986	0.6530
Notes: Q1–Q3: Lower and Upper Quartile; S-W: Shapiro-Wilk Normality Test Result.								

Compliance with CPR techniques

A worrying pattern emerged from our examination of the compliance with the standard compression-to-ventilation ratio of 30:2, which is advised by the European Resuscitation Council. It was observed that only a small percentage of paramedics strictly adhered to this important recommendation. This disparity, which ranges in size from tiny to large deviations, highlights an important weakness in practice and training. These results underline the critical need for more targeted and regular CPR instruction, given the direct effect of the compression-to-ventilation ratio on patient survival. Improving CPR results in practical situations requires paramedics to follow this recommendation.

Analysis of ventilation volumes

The study's assessment of the breathing volumes used during CPR shed light on the paramedics' abilities in a meaningful way. Ventilation volume, or the amount of air that enters the patient's lungs with each breath, is a crucial factor in ensuring that the patient receives enough oxygen during resuscitation, as illustrated in Figure 1. The data on ventilations done is clearly displayed in Fig. 1, which demonstrates that individuals vented 1857 times over the course of the study. It's concerning to note that 87.4% of these ventilations fell below the lower bound of the typical range. A notable departure from ideal practice was seen in the 124 breaths that were conducted over the optimal volume, and only 372 breaths (23.89%) were performed within the normal volume range.

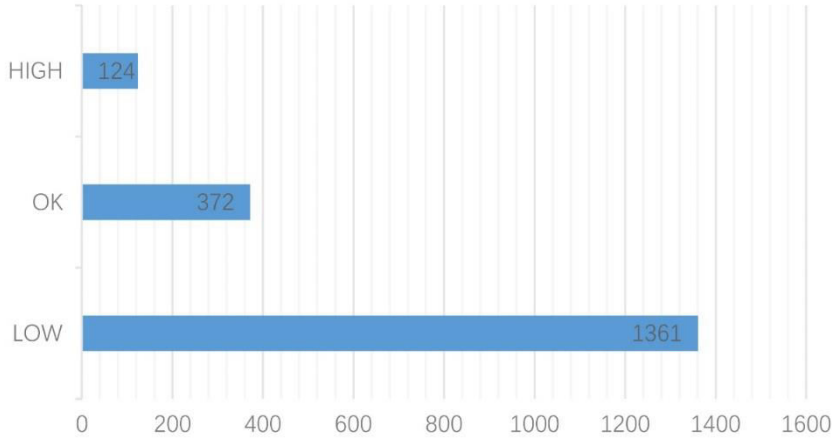

Fig 1: Distribution of ventilation volumes in CPR performance.

The quantitative data presented in Figure 1 illustrates the disparity in attaining suitable ventilation volumes, which suggests a possible deficiency in paramedics' training or expertise regarding this crucial component of CPR. The frequent departure from the optimal breathing volume indicates that improved training techniques with greater practical experience and real-time feedback are required. Enhancements in training could guarantee that paramedics are more capable of determining and administering the proper ventilation volumes during CPR, enhancing the overall efficacy of their resuscitation endeavors.

Incidence and distribution of errors in CPR

Our thorough examination of CPR methods has revealed important mistakes that paramedics make when performing chest compressions and ventilations. Concerningly high percentages of participants departed from recommended practices, which had an impact on breathing volumes and compression rates—two important aspects of CPR effectiveness and patient survival. There were errors related to under- and over-ventilation, as well as improper rates and depths in compression. These results highlight the critical need for improved, targeted training by highlighting gaps in knowledge or preparedness for emergency situations. By incorporating regular refreshers, real-world scenario simulations, and ongoing skill evaluations, we can reduce these errors and emphasize how crucial it is to provide emergency care of the highest caliber. The data presented in Table 3 provides strong support for this strategic approach to training, which aims to close performance gaps that have been discovered and maintain high-quality patient care in urgent situations.

Table 3.Occurrence of errors in CPR techniques.

Error Type	No Compression Error	With Compression Error	Total
No Ventilation Error	1 (1.45%)	13 (18.84%)	14 (20.29%)
With Ventilation Error	0 (0.00%)	55 (79.71%)	55 (79.71%)
Total	1 (1.45%)	68 (98.55%)	69 (100.00%)

Summary of cumulative errors

Table 4 presents the results of our extensive investigation, which looked at the cumulative errors made by paramedics when performing CPR. It shows a wide range of skill levels. The table shows a considerable variation in skill levels across the board by classifying errors into chest compression and breathing procedures. While some paramedics perform CPR precisely as instructed, others struggle, indicating a glaring need for focused training interventions. This heterogeneity highlights the necessity for consistent skill assessments and tailored training methods to enhance CPR performance. Table 4 shows patterns of errors that indicate the need for training tailored to address these identified deficiencies to ensure paramedics can provide high-standard emergency care.

Table 4.Number of errors committed in CPR techniques.

No. of Ventilation Errors	No Compression Errors (0)	1 Compression Error	2 Compression Errors	3 Compression Errors	Total
0 Errors	1 (1.45%)	5 (7.25%)	6 (8.70%)	2 (2.90%)	14 (20.29%)
1 Error	0 (0.00%)	8 (11.59%)	16 (23.19%)	2 (2.90%)	26 (37.68%)
2 Errors	0 (0.00%)	4 (5.80%)	10 (14.49%)	7 (10.14%)	21 (30.43%)
3 Errors	0 (0.00%)	2 (2.90%)	1 (1.45%)	5 (7.25%)	8 (11.59%)
Total	1 (1.45%)	19 (27.54%)	33 (47.83%)	16 (23.19%)	69 (100.00%)

Discussion

The investigation of the efficacy of CPR practices among paramedics yields several important findings. The most important of these is the understanding that obtaining a return of spontaneous circulation (ROSC) does, in fact, depend heavily on doing high-quality chest compressions, as stressed by current guidelines (Gräsner et al., 2020). According to our data, paramedics attained a commendable average compression depth of 58.4 mm, which is in close accordance with the 50 mm to 60 mm suggested range by the European Resuscitation Council (Considine et al., 2020).

This achievement is significant because it confirms the strong effectiveness of compressions, which is a critical factor in patient survival during SCA.

It is essential to incorporate effective chest compressions into the larger emergency medical response system. Our study emphasizes the importance of compression depth proficiency, but it also shows the necessity of a comprehensive strategy that strikes a balance between compressions and other CPR techniques. When paramedics are the initial responders—and perhaps the only ones—this comprehensive strategy is essential. In many cases, the ability to rapidly assess a situation and administer efficient CPR, including compressions and ventilations, might be the difference between life and death.

To enhance the clarity on our approach to ventilation, it is essential to note that we utilized a standard adult-size bag-valve-mask (BVM) for all ventilatory support during the CPR interventions in this study. This methodological detail, now explicitly mentioned in our methods section, aligns with widely accepted clinical practices and ensures the reliability of our ventilation-related findings. Comparative analyses with existing literature confirm that the achieved ventilation volumes are consistent with those recommended, underscoring the comparability of our results to broader resuscitation research.

It is important to emphasize that we used a typical adult-size bag-valve-mask (BVM) for all ventilatory support during the CPR interventions in this study to improve the clarity of our ventilation strategy. This methodological detail assures the validity of our ventilation-related findings and is now specifically noted in our methods section, in line with widely accepted clinical norms. The achieved ventilation volumes are commensurate with those advised by comparison analyses with the body of literature, highlighting the applicability of our findings to more extensive resuscitation study.

However, there is cause for concern regarding possible secondary injuries due to the observed range in compression depths, including severe compression up to 72 mm. Studies like those by (Hellevuo et al., 2013) have highlighted this risk, which emphasizes how crucial it is to identify the participant group that contributes to this variation to successfully reduce such hazards. On the other hand, although slight, the occasional underachievement in compression depth also needs to be addressed. These differences, however small, may have a substantial effect on the results of CPR, particularly in longer resuscitation attempts when weariness may further affect the compression depth.

We have carefully revised our reference list to more precisely reflect the most recent findings and approaches in CPR effectiveness after carefully weighing the significance of integrating current research. We have reviewed more recent research that investigates the crucial connection between ventilation efficiency and compression depth. By providing a more thorough understanding of the distinct contributions made by each component of CPR to patient outcomes, this update to our

citations strengthens our analysis and guarantees a stronger body of research to support our presentation.

In contrast, the results of our study about the depth of compressions are superior to those found in studies by Zubrzycki et al. and Dudzinski et al. that have been conducted on other professional groups, such nurses. The variation in demographics, the frequency with which CPR is performed, and the level of paramedic training could all be contributing factors to this discrepancy. All the same, our study participants did a commendable job of meeting the difficulty of applying enough compression force, which is a struggle for non-medical personnel.

The difference in compression depth that has been seen between paramedics and other medical professionals, like nurses, may be due to the different frequency and severity of CPR scenarios that occur in real life. Paramedics may need to hone their compression techniques since they often must respond quickly and decisively in high-stress situations (Al-Jaafreh et al., 2023). To determine the validity of these observations, it is crucial to make sure that these comparisons are done in the context of comparable approaches or environments.

This finding raises the possibility that the frequency and setting of CPR instruction matter just as much as the subject matter. Personalized training that mimics actual emergency situations improves the efficiency of CPR administered by medical professionals.

A significant disparity in attaining ideal tidal volumes was seen when we analyzed ventilation strategies, suggesting a possible area for paramedic training enhancement. Taking this into account, we support improved training materials that are centered on ventilation techniques. These tactics include both the technical side of breathing administration, and the essential decision-making required to modify ventilation in response to patient reaction. This modification has the potential to greatly increase the effectiveness of CPR by guaranteeing that breathing successfully supports chest compressions.

Fatigue's impact on CPR effectiveness needs to be considered. The endurance and consistency of rescuers are put to the test during prolonged resuscitations, which may affect the effectiveness of chest compressions and ventilations (Hinkelbein et al., 2020). The findings of this study point to the need for research methods to support paramedics in continuing to function at their best for extended periods of time. These tactics include using mechanical CPR equipment during prolonged resuscitation attempts and team-based approaches to CPR that permit frequent rotation to lessen individual weariness.

The time lapse between paramedics' required CPR training sessions has sparked concerns about how their abilities will be maintained and improved upon. We recommend implementing a systematic, regular approach to lifelong learning considering our findings. Reducing the duration to one year could ensure paramedics remain knowledgeable about the most recent techniques and how to handle the psychological and physical difficulties of CPR. This modification may improve the general standard of emergency services.

Chest compressions are essential, but adequate ventilation is just as important, especially in cases of asphyxial cardiac arrest (Kong & Guo, 2021). The study's finding that almost 90% of participants were unable to reach the lower tidal volume limit, and some were unable to ventilate at all, raises serious concerns. Sustaining airway patency and expertly administering replacement breaths are necessary for adequate ventilation, which is essential to the efficacy of CPR (Palisch, 2023). Our results show that we can effectively prevent standard error of air insufflation into the stomach, but they also point to the necessity for better ventilation methods.

There are concerns regarding the current emphasis on CPR training programs considering the problem of paramedics using poor ventilation procedures (Davis et al., 2010). Even while chest compressions should receive a lot of attention, it's important to remember to use the right ventilation procedures as well. For the blood to be oxygenated, effective ventilation is essential, especially in situations of prolonged cardiac arrest when the oxygen supply runs out quickly (Kopra et al., 2023). It follows that balanced training is necessary, with equal emphasis placed on ventilations and compressions.

We analyze the existing Saudi Arabian paramedic training system considering the requirement for balanced training. Although the routine teaches compression techniques well, it doesn't seem to be as good in providing paramedics with the sophisticated abilities needed for the best ventilation. One significant shortcoming is the absence of clinical exposure during training. Paramedics may be able to hone their breathing techniques under the guidance of experts through recurring internships in intensive care units or operating rooms (N/A, 2023).

The mandatory in-service training sessions' five-year gap might be too long, which could affect how well CPR skills are retained and honed. According to research, holding mandatory training sessions more frequently—ideally every two years as advised by eminent medical associations like the American Heart Association—might be a practical way to improve CPR paramedic performance overall and guarantee that all knowledge and skills are retained (Merchant et al., 2024; Sumera et al., 2024).

Although paramedics are remarkably skilled at performing chest compressions, there is a need to improve ventilation methods. Improving CPR standards and improving patient outcomes could result from addressing this through more rigorous training and clinical experience.

One cannot stress the value of ongoing evaluation and feedback during CPR instruction. Paramedics can receive real-time feedback on their compression and breathing procedures by integrating sophisticated training manikins and simulation technologies. Through the identification and correction of technique errors in a secure learning environment, this technology-enhanced approach can help improve the acquisition and retention of skills. Purchasing these training resources could be a calculated move to improve the general caliber and efficacy of CPR administered by paramedics.

The study emphasizes the necessity of continual improvement in CPR teaching through a more data-driven approach. To fill in any gaps, training materials can be updated on a regular basis through a methodical analysis of CPR performance data. Furthermore, by utilizing developments in data analytics and digital health, paramedics can receive individualized feedback and learning opportunities that will help them improve their proficiency in both chest compressions and ventilations (Goniewicz et al., 2023; Khorram-Manesh et al., 2024).

It is also important to consider how psychologically prepared paramedics are for high-stress CPR situations. The quality of CPR administered can be greatly impacted by a rescuer's mental and emotional readiness (Martin-Conty et al., 2020; Silverplats et al., 2022). Stress management and resilience training might be added to the CPR curriculum to help paramedics stay composed and focused in emergency situations, which would increase the efficacy of their resuscitation efforts overall.

When considering the study's wider ramifications, it's critical to take into account how the results from Saudi Arabia might compare to or diverge from CPR practices in other areas or against international norms. Although there are global CPR recommendations, geographical variations in emergency response protocols, training, and resources can cause disparities in practice. For example, paramedics in Saudi Arabia may confront similar obstacles and proficiency levels to those in other regions with similar medical facilities and training programs. On the other hand, CPR performance may vary in regions with different healthcare systems, resources, or cultural perspectives on emergency response. This contrast emphasizes how important it is to adapt CPR instruction and standards to local circumstances while still upholding international best practices. It also emphasizes the potential importance of multinational joint studies in gaining a thorough grasp of the global demands for paramedic training and the effectiveness of CPR.

Understanding the fundamental reasons of mistakes in CPR procedures requires considering a number of important elements. First, paramedics' proficiency might be greatly impacted by the differences in their training and educational backgrounds. Under duress, paramedics who receive regular and thorough training—especially in the form of role-playing exercises—are probably going to perform better. Conversely, infrequent or light training may result in gaps in the application of skills, especially under pressure.

When it comes to emergencies, the paramedics' physical and mental health are vital. The accuracy of both ventilations and compressions can be negatively impacted by variables like exhaustion, stress, and cognitive overload. Technical proficiency is necessary for accurate CPR performance, but physical and mental toughness are also critical, particularly for extended resuscitation attempts.

Ergonomic factors and equipment familiarity are also crucial. There may be differences in the way CPR techniques are applied depending on the type and model of CPR manikins used for training as opposed to the equipment utilized in actual scenarios. Regular practice with equipment that closely resembles real-world situations will probably make paramedics more proficient in using these skills in an emergency.

Finally, CPR performance is greatly impacted by the dynamics of the emergency, including as team collaboration and communication. To ensure the best possible administration of CPR procedures, effective collaboration and clear communication are important.

The knowledge gleaned from in-depth research emphasizes how crucial a complete approach to CPR instruction is. In addition to technical capabilities, training should cover team dynamics, stress management, and emergency adaptation. This comprehensive growth can be aided by simulation-based training and real-time feedback, which gives paramedics the skills, fortitude, and mental clarity they need in emergency situations. By improving training programs in this way, we can reduce the discrepancy between current practices and the best practices for performing CPR, which will ultimately improve the outcomes for cardiac arrest victims.

These results point to the necessity of providing paramedics with CPR training that is comprehensive. In addition to covering the technical parts of CPR, training programs should also cover psychological resilience, stress management, and familiarity with a range of emergency situations and tools. Frequent skill evaluations and feedback systems can support ongoing skill development by assisting in identifying each person's unique training needs. Through comprehension and resolution of these factors, CPR instruction can be refined to augment paramedics' general efficiency and dependability throughout crises.

Conclusion

This study, conducted by 69 paramedics in Saudi Arabia, has shed light on important aspects of CPR procedures, particularly the strengths of chest compression depth within approved guidelines. Despite this, the investigation revealed several aspects that require targeted enhancement, namely related to ventilation methods and compliance with compression-to-ventilation ratios. The observed differences in practice highlight how important it is to have regular, improved training sessions that are based on emergency situations that occur in real life. These courses ought to focus on honing paramedics' technical proficiency and crisis decision-making skills so they can provide superior CPR. It is recommended that future studies examine the effects of training improvements on the efficiency of CPR and the performance of paramedics in various emergency scenarios.

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