Original Article :

Knowledge, Attitude, and Practice Regarding Crash Cart Medications among Physicians in Primary Healthcare Centres in Saudi Arabia; A Cross-sectional Study

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Abstract

Background and Aims:
This study aims to decrease the knowledge gab in literature by investigating physician's understanding of the crash cart medications, their perception of it, and how they utilize it.

Methods:
This is a cross-sectional study targeting primary care physicians across Saudi Arabia. Stratified sampling was used in which general and family physicians were distributed over five regional strata. The sample size was determined at 366 physicians. The data distribution was tested individually for each subset using Anderson-Darling test and hence determining the appropriate statistical test accordingly. T-test and one-way ANOVA were used for parametric statistical tests, Mann-Whitney and Kruskal-Wallis were used for non-parametric tests, and finally Wald test was utilized in binary logistic regression analysis. Minitab statistical package [version 19.2020.1(64-bit)] was used to perform all statistical analysis in this research.

Result:
324 responses across Saudi were collected, with 7.04/10 as a mean knowledge score. The mean knowledge score considered high with 1.92 standard deviation. Non- Saudi physicians had significantly higher knowledge than Saudi physicians did. Physicians who reported being able to interpret electrocardiogram rhythms had significantly higher knowledge scores compared to those who could not. Easiness of performing cardiac compressions was also linked to better knowledge scores compared to those with some difficulties.

Conclusion:
Addressing the identified barriers and implementing standardized crash cart protocols in PHCs can significantly improve emergency preparedness and patient outcomes. Investing in the ongoing development of physicians' emergency management skills will ultimately enhance the overall quality of care in PHC settings.

Keywords:
Crash carts, Primary health Care Physicians, medical practices

Introduction:

The emergency department works as a first entry point for various patients with injuries and medical emergencies that could be fatal or potentially cause permanent physical damage. Additionally, emergency medical services are vital in providing urgent healthcare to patients[1]. Due to their extreme importance, emergency services are delivered not only in all hospital units but also in primary health care centers (PHCs)[2]. There are essential components that facilitate effective and timely responses in emergency situations, such as physicians, information systems, and medical equipment. Additionally, to ensure the highest possibility of patient survival, hospitals utilize mobile stocking systems, crash carts, and resuscitation trolleys, which require rigorous organization of teams and materials. One of the most important medical equipment for emergency response is the crash cart or code cart [3]. Crash carts consist of drawers on wheels that contain items used in emergency response, such as medications and medical equipment [4].

Physicians in PHCs are the first responders to a broad range of medical emergencies in the emergency room (ER), from minor complaints to life-threatening events. Thus, the usability of crash-cart medications depends highly on the knowledge, attitudes, and practices of physicians working at PHC. The effects of unfamiliarity with emergency equipment have been investigated in southern Sweden [5]. They concluded that unfamiliarity with emergency equipment poses a significant challenge that hinders the performance of emergency interventions. Moreover, the correlation between knowledge and the clinical practice of using a crash cart has been investigated in India[6]. A positive correlation between both variables was found with the recommendation to increase knowledge and training regarding crash carts. In addition, the relationship between the deficiency of knowledge and skills regarding crash carts and failure to rescue patients has been investigated in Southeast Asia [7]. It was concluded that rescue failure is the result of multiple errors, including the failure to use the crash cart.

The author searched multiple databases for further literature discussing crash carts and found a lack of literature. More specifically, there is a gap in the literature that discusses the KAP of physicians towards crash cart medication in PHC settings In Saudi Arabia. This study aims to decrease the gap in the literature by investigating physicians' understanding of crash cart medication, their perception of it, and how they utilize it. In addition, this study identified potential barriers affecting physicians' KAP for crash cart medication.

Subjects and Methods:

This cross-sectional study comprised a self-administered structured electronic questionnaire targeting physicians employed in PHCs across the Kingdom of Saudi Arabia. The survey contained consent condition before initiating the questionnaire. In addition, direct invitations were handed physically to be filled on site. The Institutional Review Board of Jeddah approved the study protocol (letter number KSA: H-02-J-002). Different classifications of physicians were considered as the population of interest for this study, including general practitioners and family physicians (consultants, senior registrars, registrars, and board residents). According to the Statistical Yearbook 2022, a total of 7751 general and family physicians were employed in Saudi Arabia [8]. We used stratified sampling in which physicians were distributed over five regional strata. The stratification consists of Western, Eastern, Northern, Southern, and Middle regions. Thus, the sample size was determined to be 366, provided with a 95% confidence level, 5% margin of error, 50% estimate proportion, and 100% expected response rate.

Based on a thorough review of the existing literature, the questionnaire was composed of four sections, which are demographic data, knowledge, attitude, and practice. Demographic data included age, sex, classification, region, courses, years of experience, and presence of clinical privilege. In the knowledge section, basic knowledge of crash cart medication was examined through questions, which were constructed professionally and revised by two external ER consultants with wide research experience. Three attitude questions were used to address the comfort of physicians in dealing with ER cases in PHCs. The last section of the questionnaire covers the current practice trends of physicians towards the management of ER cases. The answers to the third and fourth sections were structured on a Likert scale; therefore, the respondents were chosen from strongly agree, agree, neutral, disagree, and strongly disagree.

Two external professional experts with a research background in the field of ER medicine reviewed and validated the questionnaire and approved it after modification. A pilot survey of 30 participants was conducted, and Cronbach's alpha test was applied to check the Likert scale in Sections 3 and 4 (Alpha= 0.8516). Finally, minor adjustments were made to the questionnaire based on feedback from pilot survey respondents.

The co-authors used various approaches to reach the targeted samples, as they utilized electronic invitations via official e-mails (original invitation followed by repeated kind reminders), self-visits to ran-

dom PHCs across the kingdom, and social media invitations for the targeted population to participate in the study. The data collection period began in April 2024 and ended in September 2024.

The responses were expressed on a data sheet and looked upon for descriptive statistics, where we used the mean with standard deviation (SD) and the median with interquartile range (IQR) as measurements of central tendency and dispersion of the data. Therefore, the knowledge score of the respondents was summed and its mean (SD) and median (IQR) of each data subset were then calculated. The attitude responses were scored as positive (strongly agree/agree) and negative (neutral/disagree/strongly disagree), while the practice scored yes (strongly agree/agree) and no (neutral/disagree/strongly disagree). The data distribution was tested individually for each subset using the Anderson-Darling test to determine the appropriate statistical test. Generally, t-test and one-way ANOVA were used for parametric statistical tests, Mann-Whitney and Kruskal-Wallis tests were used for non-parametric tests, and the Wald test was utilized in binary logistic regression analysis. The Minitab statistical package {version 19.2020.1 (64-bit)} was used to perform all statistical analyses in this study.

Results:

The study comprised 324 responses across the Kingdom of Saudi Arabia, with a mean knowledge score of 7.04/10. Generally, the mean knowledge score was considered high with 1.92 standard deviation (SD). Throughout the results, means, standard deviations (SD), medians, and interquartile ranges (IQR) were reported and used for analysis where appropriate.

Table 1 summarizes the analysis of knowledge scores across various demographic characteristics, providing key insights into the distribution of knowledge regarding crash cart medications among PHCs' physicians in Saudi Arabia. The knowledge scores demonstrated a consistent distribution across age groups. Physicians aged 36-45 had the highest average score (mean = 7.19, SD = 1.80), while those aged 25-35 exhibited the lowest mean score (mean = 6.78, SD = 2.11).

Table 1: Comparison of Knowledge Score by Basic Demographics.

Variables		Number of Responses (%)	Mean of Knowledge Score	SD	Median of Knowledge score	IQR
Age in years	25-35	(28.7) 93	6.78	2.105	7	3
	36-45	(46.9) 152	7.19	1.8	7	3
	45<	(29.9) 79	7.07	1.93	7	3

Gender	Male	(61.1) 198	6.93	2.01	7	2.25
	Female	(38.9) 126	7.22	1.78	8	2
Nationality ^	Saudi	(29) 94	6.53	2.14	7	3
	Non-Saudi	(71) 230	7.25	1.79	7	3

^ p-value= 0.005 (t-test).

The >45 years age group had a mean score of 7.07 (SD = 1.93). Medians were consistent across age categories (median = 7), with IQRs of 3 across the board. Female physicians had a marginally higher mean knowledge score (mean = 7.22, SD = 1.78) than male physicians (mean = 6.93, SD = 2.01). The median score for females was higher (median = 8, IQR = 2) than that for males (median = 7, IQR = 2.25), although the differences were not statistically significant. The most striking demographic difference was observed in the nationality comparison. Non-Saudi physicians had significantly higher knowledge scores (mean = 7.25, SD = 1.79, median = 7, IQR = 3) than their Saudi counterparts (mean = 6.53, SD = 2.14, median = 7, IQR = 3) did. The p-value for this comparison was 0.005, indicating statistical significance.

Table 2 shows potential factors that might affect the knowledge score including physician classification, training courses, years of clinical experience and presence of clinical privilege. While variability was observed, no statistically significant differences were detected. Family medicine registrars reported the highest average knowledge scores (mean = 7.4, SD = 1.97, median = 8, IQR = 3), whereas family medicine consultants had the lowest scores (mean = 6.63, SD = 1.80, median = 7, IQR = 3). General practitioners fell in between (mean = 7.03, SD = 1.90, median = 7, IQR = 2). Despite these variations, the differences across classifications were not statistically significant ($p > 0.05$).

Table 2: Variables Affecting Knowledge.

Variables		Number of Responses (%)	Mean of Knowledge score	SD	Median of Knowledge score	IQR
Classification $	General practitioner	233 (71.9)	7.03	1.9	7	2
	Family medicineregistrar	40 (12.3)	7.4	1.97	8	3
	Family medicine senior registrar	32 (9.8)	6.93	2.15	7.5	2
	Family medicineconsultant	19 (5.8)	6.63	1.8	7	3

Mention the courses that you may have obtained #	BLS	Less than 1 years	191 (58.9)	7.01	1.92	7	2
		Within 1-2 years	18 (5.5)	7.21	1.81	8	3
		More than 2 years	115 (35.4)	6.23	2.56	6	4
		Never	0	-----	-----	-----	----
	ACLS	Less than 1 years	32 (9.8)	7.06	1.93	8	3.5
		Within 1-2 years	37 (11.4)	7.16	1.53	8	1.5
		More than 2	58 (17.9)	7.34	1.83	7	3
		never	197 (60.8)	6.93	2.02	7	2
	ATLS	Less than 1 years	18 (7.6)	6.6	2.11	7.5	3.25
		Within 1-2 years	4 (1.2)	7.2	0.95	7.5	1.75
		More than 2 years	22 (6.7)	7.4	1.73	7	2
		never	280 (86.4)	7.07	1.94	7	2
Years of Experience *	Less than 5 years		87 (26.8)	6.82	.04	8	3
	Within 5-10 years		107 (33)	7.00	1.98	7	2
	More than 10 years		130 (40.1)	7.2	1.79	7	3
Are you clinically privileged ^	Yes		172 (53)	6.85	1.95	7	2
	No		152	7.21	1.89	7.5	3

No significant difference was found using one-way ANOVA.
 # No significant difference was found using Regression Analysis.
*** No significant difference was found using Kruskal-Wallis test.**
^ No significant difference was found using Mann-Whitney test.

Participation in life-saving courses such as Basic Life Support (BLS), Advanced Cardiac Life Support (ACLS), and Advanced Trauma Life Support (ATLS) showed some differences in scores, but none reached statistical significance. For example, physicians who completed BLS within the last 1-2 years had higher scores (mean = 7.21, SD = 1.81, median = 8, IQR = 3) than those who completed it over two years ago (mean = 6.23, SD = 2.56, median = 6, IQR = 4).

Similarly, ACLS-trained physicians within the last two years showed higher scores (mean = 7.34, SD = 1.83, median = 7, IQR = 3) than those who had completed it earlier.

Physicians with more than 10 years of experience had a slightly higher mean score

(mean = 7.2, SD = 1.79, median = 7, IQR = 3) than those with less than five years of experience (mean = 6.82, SD = 2.04, median = 8, IQR = 3). Physicians with privileges scored slightly lower (mean = 6.85, SD = 1.95, median = 7, IQR = 2) than those without privileges (mean = 7.21, SD = 1.89, median = 7.5, IQR = 3).

Regional analysis of knowledge scores did not reveal significant geographic disparities in knowledge of crash-cart medications (Table 3). The middle Region had the highest average knowledge score (mean = 7.22, SD = 1.99, median = 8, IQR = 3), whereas the Western Region had the lowest (mean = 6.84, SD = 1.93, median = 7, IQR = 2.25). Other regions, such as the Northern and Southern regions, showed comparable medians (median = 8) and IQRs (3). The Kruskal-Wallis test indicated no significant differences between regions.

Table 3: Knowledge Score Differences by Region *.

Region	Number of Responses (%)	Mean of Knowledge Score	SD	Median of Knowledge Score	IQR
Eastern Region	59 (18.2)	7.08	1.89	7	3
Western Region	114 (35.1)	6.84	1.93	7	2.25
Middle Region	95 (29.3)	7.22	1.99	8	3
Southern Region	27 (8.3)	7.07	1.89	8	3
Northern Region	29 (8.9)	7.17	1.83	8	2.5

***No significant difference was found using Kruskal-Wallis Test.**

A significant association was found between physicians' attitudes toward handling emergencies and their knowledge of crash cart medications (Table 4). Physicians who reported feeling comfortable managing emergencies at their PHC centers had significantly higher knowledge scores (mean = 7.15, SD = 1.86, median = 7, IQR = 2) than those who did not (mean = 6.81, SD = 1.98, median = 7, IQR = 3), with a p-value of 0.013. Those willing to engage in emergency management and treatment had similarly higher scores (mean = 7.18, SD = 1.89, median = 7, IQR = 3) than those who were less willing (mean = 6.79, SD = 1.96, median = 7, IQR= 3), which was statistically significant (P = 0.017). Physicians who felt competent using crash cart medications during emergencies demonstrated higher knowledge (mean = 7.22, SD = 1.84, median = 7, IQR = 2) than those who did not (mean = 6.79, SD = 1.95, median = 7, IQR= 3), with a p-value of 0.04.

Table 4: Association between Knowledge Score and Attitude.

Attitude Question	positive Attitude (%)	Negative Attitude (%)	Knowledge Score Coefficient	p-value
I feel comfortable in dealing withemergency cases at PHC	161 (49.6)	163 (50.4)	0.1486	0.013 *
I am willing to treat emergency casesat PHC center	185 (57)	139 (43)	0.1415	0.017 *
I feel competent using crash cartmedications while dealing withemergency cases at PHC level	155 (47.8)	169 (52.2)	0.122	0.04 *

***Using Wald test in binary logistic regression.**

Table 5 exploring the association between current practice and knowledge of crash cart medications, with notable correlations found. Physicians who reported being able to interpret ECG rhythms had significantly higher knowledge scores (mean = 7.36, SD = 1.76, median = 8, IQR = 3) compared to those who could not (mean = 6.74, SD = 2.07, median = 7, IQR = 3), with a p-value of 0.01. Easiness of performing cardiac compressions was also linked to better knowledge scores (mean = 7.41, SD = 1.71, median = 8, IQR = 3) compared to those with some difficulties (mean = 6.68, SD = 2.30, median = 7, IQR = 4), showing strong statistical significance (p = 0.001). Though the positive coefficient of knowledge score indicating the tendency of practicing, the remaining practices were not significantly associated with high knowledge.

Tabe 5: Association between Knowledge Score and Practice.

Practice Question	Yes (%)	No (%)	Knowledge Score Coefficient	p-value
recognize and diagnose differentcardiac emergencies	183 (56.4)	141 (43.6)	0.0795	0.173
I recognize and interpret ECG rhythm	201 (62)	132 (38)	0.1536	0.01 *
I easily perform external cardiaccompressions	249 (76.8)	75 (23.2)	0.2236	0.001 *
I easily use DC shock (cardioversion)	175 (54)	149 (46)	0.0938	0.108
I easily order administration ofemergency drugs	158 (48.7)	166 (51.3)	0.0693	0.234

***Using Wald test in binary logistic regression.**

Discussion:

This study aimed to evaluate physicians' knowledge, attitudes, and practices regarding crash cart medications in PHCs. The findings revealed several important insights that align with the existing literature, while highlighting specific areas of concern and improvement within the Saudi Arabian healthcare system.

A key finding was the significant difference in knowledge scores between non-Saudi and Saudi physicians, with non-Saudi physicians demonstrating higher levels of knowledge. This disparity could be attributed to differences in the training curricula and exposure to emergency care protocols, as non-Saudi physicians may have undergone more rigorous training in their respective countries. Previous research has also documented variability in knowledge related to emergency protocols across different healthcare settings. This suggests that structured, continuous education is essential for maintaining high levels of preparedness among healthcare professionals, irrespective of their background. Standardizing training protocols across healthcare centers in Saudi Arabia could help bridge this knowledge gap and ensure that all physicians are adequately prepared to handle emergencies [9,10].

The study also highlighted a strong correlation between physicians' confidence in using Crashcart medications and their knowledge levels. Physicians who felt more comfortable and confident about using crash cart equipment scored higher on knowledge assessments. This finding is consistent with previous studies that have shown a direct link between healthcare professionals' confidence in their skills and their performance in emergency situations. Therefore, building physician self-efficacy through targeted training interventions could play a crucial role in improving emergency care. Simulation-based training, which has been shown to enhance both confidence and practical skills in managing critical situations, could be a valuable tool for PHCs' physicians. By allowing physicians to practice emergency scenarios in a controlled environment, simulation training can help reduce anxiety and improve decision-making during real-life emergencies [11,13].

In terms of practical applications, the study found that physicians with strong skills in interpreting ECG rhythms and performing cardiac compressions were more knowledgeable about crash-cart medications. This aligns with the broader body of research emphasizing the importance of hands-on experiences in improving emergency care outcomes. Physicians who regularly engage in practical training are better equipped to respond quickly and effectively to critical situations. These

results underscore the need for more opportunities for physicians to practice using crash carts in simulated settings, as regular drills and simulations have been shown to reduce response times and improve the accuracy of medication administration during emergencies. Incorporating these practices into routine training could significantly enhance the overall preparedness of PHC physicians in Saudi Arabia [14,16].

Several barriers to effective crash cart use have been identified, including inconsistent training and lack of confidence regarding the use of crash carts among some physicians. These challenges are not unique to this study, as similar issues have been reported in healthcare settings worldwide. Inconsistent training and unfamiliarity with crash cart layouts have been associated with delayed responses during emergencies, emphasizing the need for more standardized training approaches. One potential solution is to standardize both the layout and content of crash carts across healthcare centers, ensuring that all physicians and healthcare staff are familiar with the equipment and can act quickly in critical situations. Regular audits and feedback on crash cart preparedness could also help ensure that healthcare professionals remain vigilant and ready to respond to life- threatening emergencies [17, 18].

The findings of this study have several implications in clinical practice. Continuous education programs tailored specifically to PHC physicians should be developed with an emphasis on both theoretical knowledge and hands-on practice. Simulation-based training, in particular, has the potential to improve both confidence and competence among physicians, ensuring that they are well-prepared to manage emergencies. Additionally, integrating crash cart readiness into physicians' ongoing professional development could further enhance their preparedness. This is particularly important in PHCs, where resources may be more limited than in tertiary hospitals. Standardizing crash cart systems across all healthcare facilities, along with regular training and audits, could lead to a more streamlined approach to emergency care and ultimately improve patient outcomes [18].

Although this study offers valuable insights into physicians' knowledge, attitudes, and practices regarding crash cart medications, it has some limitations. The cross-sectional design captures data only at a single point in time, which may not fully reflect changes in knowledge or attitudes over time. A longitudinal study could provide comprehensive insights into how knowledge and skills evolve with continued training and experience. Furthermore, while the sample size was robust, the use of cluster sampling could have introduced

regional biases as healthcare resources and training opportunities may vary significantly across different regions in Saudi Arabia.

Another potential limitation was identified as the majority of the study respondents were non- Saudi physicians despite the increase in the actual field survey distribution. This may also be referred to the drawback of the voluntarily cross-sectional survey. Nonetheless, the number of Saudi respondents was still statistically representative for comparison. More importantly, the main objective of this study was not to compare Saudis to non-Saudis when it comes to the KAP of crash cart medications, rather it focuses on the health care providers in the Saudi primary health care centers. Future research should explore these regional differences in greater detail to better understand how healthcare systems can support physicians in diverse settings.

Conclusion:

This study highlights several critical areas where improvements can be made to enhance physicians' knowledge, attitudes, and practices concerning crash-cart medications. The significant variability in knowledge across demographic groups as well as the strong relationship between confidence and preparedness underscores the importance of continuous education and simulation training. Addressing identified barriers and implementing standardized crash cart protocols in PHCs can significantly improve emergency preparedness and patient outcomes. Investing in the ongoing development of physicians' emergency management skills will ultimately enhance the overall quality of care provided in PHC settings.

Conflict disclosure:

The authors have no conflict of interest to declare.

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Statement of Ethics:

This study protocol was reviewed and approved by the local IRB in Jeddah health affairs according to KACST (GCP) regulations, with the approval number of [A01906].

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