


The Effect of Flipped Learning of Medical Emergency Protocols on the Knowledge of Medical Emergency Personnel

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ABSTRACT

Emergency medical personnel bear a critical responsibility in administering care to severely injured patients; however, research has demonstrated that their knowledge levels range from moderate to inadequate. Consequently, the present study sought to determine the effect of offline flipped learning protocols on the knowledge of emergency medical personnel employed in Khorramabad, Iran. In this field trial, 70 medical emergency technicians from the Central Emergency Department of Khorramabad in 2021 were randomly assigned to control and intervention groups. To assess their knowledge levels, the researchers developed a questionnaire based on offline resources that instruct on medical emergency protocols. The intervention group engaged with offline educational resources on protocols disseminated via WhatsApp and Baleh messaging applications. Subsequently, face-to-face meetings were conducted at the clinical skills center for group discussions and case report exchanges. The control group adhered solely to offline protocols as per routine practice. The average knowledge scores of the intervention and control groups differed significantly post-intervention. A notable increase in the mean knowledge score was observed in the intervention group (43.67 ± 1.79) compared to the control group (12.35 ± 3) ($p < 0.001$). The implementation of the flipped learning approach, in conjunction with social messaging applications/platforms, has proven advantageous in enhancing the knowledge of medical emergency personnel. Therefore, managers and educational planners are encouraged to adopt innovative teaching techniques in in-service training to ensure the delivery of comprehensive and safe services in medical emergency facilities. Further research is recommended to explore the impact of inverted training on the performance, self-efficacy, and clinical reasoning of emergency medical technicians.

Keywords: Flipped learning; Medical emergencies; Knowledge

Introduction

Human resources constitute a critical component of organizational systems. The recruitment, retention, and effective utilization of skilled and competent individuals significantly enhance an organization's likelihood of achieving its objectives. To optimize staff effectiveness and proficiency, it is imperative that personnel receive both informal and organizational education and training, supplementing their formal educational backgrounds [1]. Formal education encompasses the structured and hierarchical

learning provided by educational institutions, ranging from nurseries to universities [2]. Informal education is categorized into in-service education and technical occupational education. In-service education is defined as the acquisition of knowledge, skills, and work capabilities imparted to employees within the workplace [3]. The primary mission of medical science universities in Iran is to cultivate and train personnel equipped with the necessary knowledge, attitudes, and skills to advance societal health [4].

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The quality of healthcare services is intrinsically linked to the operational performance of medical emergency technicians, who are pivotal in ensuring the delivery of superior services [4].

As science and technology evolve, and medical sciences become increasingly complex due to technological advancements, patient demands also grow more intricate. Consequently, educators in medical science are required to assume more complex and demanding roles. Traditional instructional methods are insufficient for imparting the latest scientific developments to medical science students [5].

Most educational programs for medical emergencies employ conventional teaching methods, where instructors primarily serve as knowledge transmitters [6]. A significant limitation of this transmission model is the lack of active student engagement in information processing, which hinders their ability to translate knowledge into action. To address these limitations, educators have adopted learner-centered methods that actively involve students in the learning process [7]. In the realm of educational technology, there is a growing interest in online educational methods and mixed-mode learning, which are learner-centered approaches [8]. While alternative approaches such as flipped learning offer benefits, the findings of Alessanca and colleagues indicate no significant differences between flipped and traditional learning approaches concerning self-directed learning [78]. However, flipped learning has been shown to enhance students' motivation and learning outcomes [2,6].

The implementation of various innovative educational methods, including lectures, group learning, and virtual learning, can enhance the effectiveness of continuing education [9]. The flipped classroom approach, a contemporary pedagogical model that leverages technology, is experiencing expansion [10]. According to the flipped classroom approach, learners engage in participatory learning by watching recorded videos of lectures whenever and wherever they are accessible, studying the assigned materials,

and completing designated learning tasks before attending classes [11].

In light of the rapid advancements and developments across various scientific domains, it has become imperative to offer in-service education to self-directed and independent learners. Flipped learning has been shown to effectively enhance learners' readiness for self-directed learning and is recommended as a complement to traditional teaching methods [32].

Emergency medical technicians typically require extensive in-service training to adequately prepare for emergencies, provide initial aid and support to the injured, maintain and update their medical knowledge, enhance productivity, minimize professional errors, and improve their working environment. Despite numerous studies on educational methods, the application of flipped learning in the education of medical emergency technicians has largely been overlooked. Furthermore, the impact of integrating this approach with other instructional techniques on the level and quality of knowledge, performance, and self-directed learning among medical emergency professionals has not yet been thoroughly investigated.

Therefore, considering the importance of making informed decisions to prevent the exacerbation of issues in this field, the dissipation of financial resources, the preservation of patient safety in primary care, and the maintenance of optimal standards of care, the present research was conducted to evaluate the efficacy of the flipped learning method. This method may be proposed as an effective instructional strategy for the in-service education system if it proves to enhance human resources in emergency medical organizations.

Materials and Methods

The present study employed a controlled pretest–post-test field trial design. The study population comprised prehospital medical emergency technicians holding associate's and

bachelor's degrees in nursing, emergency medicine, anesthesia, and operating room technology, all working in the central emergency department of Khorramabad, Iran. Convenience sampling was utilized to enroll participants based on inclusion and exclusion criteria until the target sample size was reached. Participants were divided into experimental and control groups, balanced according to their characteristics. The sample size was estimated to be 43 participants in each group, based on the study by Nourian et al. [12].

To account for confounding variables and mitigate the impact of the intervention group on the control group, the control group was studied first. Subsequently, the intervention was implemented in the experimental group using a hybrid approach that included both virtual and in-person methodologies. The researcher established WhatsApp and Baleh (an Iranian messaging app) groups and coordinated separate online briefing sessions with both groups at prearranged intervals. Questionnaires were designed on the *porline.ir* website to assess participants' knowledge. Separate links for the questionnaires were distributed among personnel through virtual groups at designated times. Both groups completed a virtual pre-test prior to the intervention.

The participants' knowledge levels were evaluated using a pre-test and post-test questionnaire, which was developed based on the offline protocols of the Iranian Ministry of Health and Medical Education.

This questionnaire comprised demographic information and 46 questions derived from the aforementioned protocols. The scoring system ranged from 0 to 46, encompassing eight domains: Traffic Accident Scene Investigation and Analysis (four questions), Snakebite (three questions), Frostbite (three questions), Trauma Patient Evaluation (eight questions), Patient's Airway Obstruction (eight questions), Resuscitation and Shock (nine questions), Drowning (five questions), and Management of Acute Heart Disease in Trauma Patients (six questions).

The validity of the questionnaire was confirmed by several emergency medicine specialists. Reliability was established with a Cronbach's alpha of 0.888, and the correlation between pre-test and post-test scores was calculated at 0.812 ($p < 0.005$).

The inclusion criteria for this study required that operational technicians possess expertise in emergency medical nursing, anesthesia, and operating room technology; express willingness to participate in the research; provide written informed consent; own a smartphone or laptop; and demonstrate the ability to use a smartphone and social networks.

Exclusion criteria included participants' unwillingness to continue participation, termination of the project contract, non-participation or absence from any training sessions, changing mobile phone numbers without notification, and participation in similar training courses before or during the research.

Descriptive statistics were utilized to describe the data. Independent t-tests, paired t-tests, and covariance tests were employed for data analysis. Chi-square and Fisher's exact tests were used to assess qualitative variables between the two groups. All statistical analyses were conducted using SPSS 25, with statistical significance set at $P < 0.05$.

Ethical considerations included obtaining consent letters from participants, indicating their willingness to participate in the research and their assignment to one of the groups. The intervention did not disrupt participants' work or rest schedules. The flipped learning process was administered to the control group. To incentivize the staff to engage in the study, participants were awarded bonuses, such as credits for career promotion.

Lorestan University of Medical Sciences provided the code of ethics (IR.LUMS.REC.1401.100).

Results

Statistical analysis using Fisher's exact test revealed no statistically significant difference in age and educational level between the intervention and control groups ($P < 0.05$). Furthermore, the chi-square test that was used to compare the educational levels among the groups did not show any statistically significant difference ($P = 0.955$).

Based on the data presented in Table 1, there was a statistically significant difference between the two groups regarding the mean total knowledge score before the intervention ($P = 0.046$). Furthermore, following the intervention, a notable disparity was noted between the two groups regarding the given variable ($P = 0.001$). However, the comparison of the changes in the knowledge score between the two groups also revealed that the intervention group did experience a significantly more significant increase in the overall knowledge score ($P = 0.001$).

Tables 3 show the results from the covariance test comparing the mean total knowledge score after the intervention between the intervention and control groups with the adjustment of the pre-test total knowledge score effect. After adjusting the

pre-test score, the mean score of total knowledge (standard error) in the intervention and control groups was 43.60 (0.343) and 37.79 (0.343), respectively, indicating statistical significance ($p < 0.001$). Furthermore, the paired t-test in Table 3 revealed a significant difference ($P < 0.05$) in the mean values of total knowledge, resuscitation, snakebite, acute cardiac illness, and air obstruction between the intervention group pre- and post-intervention. Contrary to expectations, there was no notable disparity in the mean knowledge of trauma, frostbite, traffic accident scene investigation and analysis, and drowning pre- and post-intervention in the intervention group ($P < 0.05$).

The results from the paired t-test in Table 4 indicate a significant difference in the mean resuscitation knowledge between the control group pre- and post-intervention ($P < 0.05$). Additionally, there was no statistically significant disparity in the mean scores of total knowledges as well as knowledge of trauma, frostbite, snakebite, acute heart disease, airway obstruction, traffic accident scene investigation and analysis, and drowning pre- and post-intervention in the control group ($P < 0.05$).

Table 1. Comparison of the mean total knowledge score between the intervention and control groups pre- and post-intervention

Variable	Group	Mean (SD)	P value*
Total Knowledge (pre-)	Intervention	26.72(3.06)	0.046
	Control	25.37(3.12)	
Total Knowledge (post-)	Intervention	43.67(1.79)	0.001
	Control	37.72(2.59)	
The difference before and after the test	Intervention	16.95(3.27)	0.001
	Control	12.35(3.80)	

Table 2. Covariance analysis of post-test total knowledge score while adjusting for the pre-test total knowledge score

Sources of variance	Sum of Squared	Degrees of Freedom	Mean Squared	F	P value*
Total knowledge score before the intervention	8.677	1	8.677	1.759	-----
Group	692.930	1	692.930	140.476	<0.001
Error	409.417	83	4.933	-	-----
Total	143622	86	-	-	-----

Table 3. Comparative analysis of mean knowledge levels in the intervention group pre- and post-intervention

Variable		Mean (Standard Deviation)	P value*
Total Knowledge	Pre-	26.72(3/06)	0.026
	Post-	43.67(1/79)	
Knowledge of trauma	Pre-	5.00(1/57)	0.102
	Post-	7.74(0/54)	
Knowledge of resuscitation	Pre-	6.12(1/07)	0.038
	Post-	7.90(1/43)	
Knowledge of frostbite	Pre-	1.53(0/85)	0.367
	Post-	2.81(0/45)	
Knowledge of snakebite	Pre-	1.30(0/60)	<0.001
	Post-	3.00(0/00)	
Knowledge of acute heart disease	Pre-	3.56(1/03)	<0.001
	Post-	5.72(0/50)	
Knowledge of airway limitation	Pre-	4/49(1/62)	0.032
	Post-	7/79(0/46)	
Knowledge of drowning	Pre-	2.58(0/82)	0.305
	Post-	3.84(0/37)	
Knowledge of traffic accident scene investigation and analysis	Pre-	2.14(0/83)	0.546
	Post-	4.86(0/35)	

Table 4. Comparative analysis of mean knowledge levels in the control group pre- and post-intervention

Variable		Mean (SD)	P value*
Total Knowledge	Pre-	25.37(3.12)	0.415
	Post-	37.72(2.59)	
Knowledge of trauma	Pre-	4.95(1.49)	0.425
	Post-	6.98(0.89)	
Knowledge of resuscitation	Pre-	5.14(1.50)	<0.001
	Post-	6.07(1.44)	
Knowledge of frostbite	Pre-	1.58(0.79)	0.880
	Post-	2.58(0.59)	
Knowledge of snakebite	Pre-	1.37(0.65)	0.491
	Post-	2.49(0.73)	
Knowledge of acute heart disease	Pre-	3.56(1.14)	0.835
	Post-	5/14(0.86)	
Knowledge of airway limitation	Pre-	4.46(1.45)	0.464
	Post-	6.93(1.05)	
Knowledge of drowning	Pre-	2/12(088)	0.356
	Post-	3/49(0/67)	
Knowledge of traffic accident scene investigation and analysis	Pre-	2.19(0.85)	0.284
	Post-	4.05(0.90)	

Discussion

The findings of the current study indicate that implementing flipped learning education is beneficial and efficient for enhancing the knowledge of medical emergency personnel. Empirical data suggest that knowledge attainment is of significant importance for emergency medical personnel. This is because progress in knowledge will facilitate the

development of novel approaches for handling the care of patients and injured individuals. Consequently, this motivates these personnel to augment and update their information and knowledge to make prompt and suitable reactions. [13]

Bayram et al.'s study demonstrated a significant enhancement in nursing students' understanding of patients' blood pressure within the flipped education group. Other

researchers have reported similar findings regarding the efficacy of flipped classrooms and self-directed learning in the education of medical, nursing, and emergency medical students [13-16]. Additionally, the professional responsibilities of prehospital emergency technicians are becoming increasingly complex and sophisticated each year, necessitating higher levels of expertise and knowledge [17].

Evidence strongly supports the need for developing innovative educational approaches in the in-service training of emergency medical workers to facilitate deep learning and retention of current information [18]. Researchers such as Dehghannejad et al. have documented that the majority of prehospital emergency staff possess a moderate-to-low level of knowledge and performance concerning the care of trauma patients and trauma education. They subsequently proposed a revision of the pre-hospital emergency curriculum and the necessary training for personnel during their service [19].

Furthermore, Herro et al. demonstrated the effectiveness of the flipped classroom approach in acquiring knowledge regarding the pathophysiology of the respiratory system [20]. Previous studies have also examined the impact of the flipped method of instruction on medical, nursing, and dental students across various fields [21-23]. These studies yielded similar findings on enhancing learners' knowledge, indicating that flipped teaching may improve learners' knowledge in diverse fields. Research conducted by Wei indicated that a deficiency in knowledge and inadequate abilities will result in long-lasting health problems and significant harm to affected individuals [18]. Thus, selecting an appropriate instructional approach to achieve enduring knowledge among healthcare technicians about significant and fundamental topics in in-service training is crucial. Sedaghatkar et al. also demonstrated that the flipped combined approach of microlearning and task-based learning is a successful clinical training approach for enhancing the knowledge and performance of medical students in an actual work setting [24].

Hence, it is advised that individual learning be integrated into a broader teaching-learning ecosystem, particularly in practical work settings, and that task-based learning be employed in clinical education settings. Another finding of the current study was the changes in the levels of acquired knowledge observed in the control group. This may be attributed to the frequent exposure of emergency medical personnel to the assessment of actual emergency operations or their involvement in emergency missions in cold urban areas, which ensures adequate expertise in this domain. Furthermore, the observed changes in the levels of knowledge within the control group indicate that uploading offline protocols to social messengers offers certain benefits compared to the conventional approach. However, it was less successful than the flipped training/teaching methodology in enhancing learners' knowledge levels. Indeed, the data indicate that using innovative instructional approaches in the ongoing education of emergency medical staff is crucial for fostering profound learning and acquiring up-to-date knowledge [18]. Additional research, such as that conducted by Belandan et al. [25], recommended that educational institutions prioritize using this instructional approach in the execution of training and retraining programs [25]. Furthermore, Abutaleb et al. found that the adoption of novel instructional approaches, as opposed to conventional and classical techniques, has a beneficial impact on students' acquired knowledge and academic achievement [21].

Limitations

An inherent limitation of the present study is its focus on a particular group of emergency medical staff from one medical center. Therefore, it is recommended to exercise caution when extrapolating the results to other professionals at various educational facilities. In addition, it is plausible that the participants underwent training through means other than those disclosed to the researcher, leaving the researcher's oversight. However, when explaining the need to complete the questionnaires accurately, the participants were

explicitly asked to reveal any comparable training they had received. Additional limitations of this study included scheduling conflicts for personnel attendance in in-person classes, demanding work schedules, and the scattered nature of emergency centers. These challenges were mostly addressed by forming small groups and conducting question-and-answer sessions. Furthermore, the convenient availability of educational information, the opportunity to read and review materials, and the use of question and answer were effective strategies that enhanced the training of the participants by the specific requirements of their professions.

Conclusion

Given the documented effectiveness of the flipped education approach and considering the role of social messengers in promoting consistent learning and enhancing the knowledge of emergency medical personnel, it is recommended that managers and educational planners implement new teaching methodology in in-service training for their employees to ensure the provision of comprehensive and safe services in emergency medical centers. Subsequent research should also explore the impact of flipped learning/training on emergency medical workers' performance, self-efficacy, and clinical reasoning.

Conflict of Interests

Authors declare that they do not have any conflict interests.

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