Original Article

Access this article online

Quick Response Code:

Website: www.jehp.net

DOI: 10.4103/jehp.jehp_782_22

Clinical reasoning in emergency medical technicians and its compliance with the illness script theory: A pilot study

Hamidreza Miri, Elham Boushehri[1], Maryam Hoseini-Abardeh[2], Shahram Yazdani

Abstract:

BACKGROUND: Emergency medical technicians (EMTs) play a pivotal role in the management and treatment chain of emergency patients and their health outcomes. Knowing the clinical reasoning pattern in prehospital procedures is of particular importance that can help to develop a correct clinical decision-making process in this group. Therefore, this study aimed to clarify the clinical reasoning in EMTs and evaluate its compliance with the "illness script" theory.

MATERIALS AND METHODS: This descriptive–analytical study was conducted in 2021 at Hormozgan University of Medical Sciences (HUMS) by involving EMTs in two groups of experts and novices. To collect and analyze participants' mental script-based information, the "think aloud" method was used. In the content analysis of extracted protocols, two main steps were considered: 1) preparing a suitable map to compare the protocol with the base pattern and 2) quantifying the relationship between the protocol and the base pattern. Statistical Package for the Social Sciences (SPSS)-21 software, the Shapiro–Wilk test, and the independent *t*-test were used for analyzing quantitative data.

RESULTS: After exploring the concordance of the clinical reasoning of EMTs with the base pattern, results showed that the components of Enabling condition and Management were consistent with the illness script strategy. Pathophysiology and Diagnosis components did not conform to the base pattern. Regarding Signs and Symptoms, these were significantly different from the classic pattern of illness script. A new component called Contextual insight was suggested for this pattern. Generally, on comparing the clinical script content of experts and novices, only two components of Pathophysiology and Diagnosis did not show any significant difference ($P > 0.05$) between these two groups.

CONCLUSION: Results of evaluating the clinical reasoning of the under-study groups showed that in some components of the pattern, they practiced as in other medical groups, but in relation to some components, this was not the case. It is due to the different nature of the prehospital conditions. Also, there is a need to add new components to the base model, which should be considered in distinguishing between expert and novice EMTs.

Keywords:

Clinical Reasoning, emergency medical technicians, illness script, thinking

Department of Medical Education, Virtual School of Medical Education and Management, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [1]Medical Education Department, Medical School, Hormozgan University of Medical Sciences, Bandar Abbas, Iran, [2]National Agency for Strategic Research in Medical Education, Tehran, Iran

Address for correspondence:
Dr. Shahram Yazdani, Department of Medical Education, Virtual School of Medical Education and Management, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
E-mail: Shahram.yazdani@yahoo.com

Received: 07-06-2022
Accepted: 11-07-2023
Published: 28-04-2023

Introduction

Along with the researchers' efforts to explain clinical reasoning by the experts and novices, some attention has been turned to a new concept called "script" in the field of reasoning and decision-making. It explains how the stored knowledge in the mind is structured, as well as shows the knowledge stored in the expert mind has a different structure than the novice.[1]

A script in medical science means that a physician categorizes all the signs, symptoms, and causes associated with

How to cite this article: Miri H, Boushehri E, Hoseini-Abardeh M, Yazdani S. Clinical reasoning in emergency medical technicians and its compliance with the illness script theory: A pilot study. J Edu Health Promot 2023;12:122.

each disease as a single mental package or a list-like structure and stores in the mind. These mental structures improve gradually with increasing clinical experience (quantitatively and qualitatively), so that they are easily activated and retrieved in the mind in the face of the first signs of related diseases.[2,3]

Activation of mental script means the representation of all the information that has been stored in the mind of the physician regarding the diagnosis and management of the disease. The formation of mental script begins immediately after the first clinical encounters of a physician.[4] Therefore, their quantitative and qualitative improvement directly correlates with experience, so that the variety and content quality of the scripts in experienced physicians are more than in novices.[5]

Based on script theory, clinical reasoning means the ability of a physician to retrieve mental scripts related to the clinical situation they have encountered.[5] Because the mental scripts of an expert are more varied and complete than those of a novice, their diagnoses are more accurate and correct. In contrast, a person who is a beginner in the field of medicine has no scripts related to the clinical situations he or she is facing or scripts are incomplete in terms of the content necessary to diagnose and manage the disease.[6]

Clinical decision-making, also known as clinical reasoning and clinical judgment, due to its vital importance for accurate and safe diagnosis and management has been studied more seriously in recent decades.[7-11] Meanwhile, various studies have examined the decision-making and clinical reasoning in various health-care professions,[9] including nursing.[12-17]

According to a literature review, very little research has been done on clinical decision-making in prehospital settings[18] and in the context of the emergency medical services (EMS).[19] Weaknesses in clinical decision-making will lead to clinical errors that are common in health care and often affect patient safety. Therefore, clinical decision-making is a very important component in research related to patient safety.[20,21] These issues are also closely related to the provision of EMS.[19]

The goal of prehospital care is to improve patient outcomes and the effective use of limited resources by referring patients with specific clinical conditions to equipped hospitals. So, to optimize such care, there should be a special mechanism or criteria in the training courses of emergency technicians, which can strengthen anticipation and early detection skills in specific situations.[22,23]

Many emergency patients have high-urgency, time-sensitive situations (both traumatic and nontraumatic patients). As a result, it is necessary to know more about the way and process of thinking, clinical reasoning, and clinical decision-making of emergency medical technicians (EMTs).[24] On the other hand, due to the educational short period, deficiencies in educational systems, and the lack of sufficient opportunities to gain more experience, the need to employ this group as soon as possible causes many problems in their decision-making process.

Generally, out-hospital procedures and the prehospital care system are crucial to health outcomes. Considering the lack of accurate and reliable information on how to make clinical decisions by EMTs as one of the prehospital providers, studying how to create an illness script by this group becomes essential. Indeed, understanding the mechanisms of the clinical reasoning process to identify knowledge gaps within this context can help planners develop more rich training programs in this profession.

Therefore, this pilot study aimed to clarify the process of clinical reasoning in EMTs and its compliance with the theory of illness script.

Materials and Methods

This descriptive–analytical study was conducted in 2021 at Hormozgan University of Medical Sciences (HUMS) with the cooperation of the Disaster and Emergency Management Center. The qualitative approach used in this study is based on "thinking aloud" method. The different steps of the study were described as follows.

Study population and inclusion criteria

In the present study, participants were selected for both novice and expert groups from among the EMTs based on their work experience. In this way, the head of the HUMS EMS Center was asked to introduce a number of technicians with less than 1 year of experience and a number of technicians with more than 10 years of experience (satisfying two conditions: they were not necessarily known as strong and active people and had appropriate verbal skills). Then, they were contacted, and the necessary arrangements were made to meet them.

Other inclusion criteria were the conditions that are generally recommended for all participants in research using thinking aloud.[25,26]

Ensuring the accuracy of participants' classification

The studies related to expertise agree that the experience and years of employment in a profession are one of the factors determining the level of expertise.[5] So, in this study, researchers used the number of years of employment as the criterion to classify participants into both expert and novice groups. In addition, the researchers in this study sought to use strategies to reassure the accuracy of the division of individuals into

two groups. One of the methods of analyzing the findings that led to the re-examination of this classification was to examine the similarity of the clinical scripts of the two groups with the clinical scripts extracted from the minds of expert panel members.

The expert panel in this part of the study means a group consisting of three physicians specializing in emergency and internal medicine and one emergency medical instructor. The extracted data were reviewed and confirmed by two medical education specialists.

Exclusion criteria

Based on the following two criteria, participants were excluded from the study:

1. Refusal of the participant to continue participating in the study in all stages of recording and analyzing information
2. Inability of the participant to adapt to interviewing by thinking aloud.

Sample size and sampling method

Some studies have put the sample size required for think aloud (TA) studies at five, and others have used between five and 10 people.[26] Also, according to the type of qualitative study, the "saturation" property was used to determine the adequacy of the sample size. In the current study, the sample size was initially considered as 10 people and it was decided to increase the size if there was no saturation. In this way, an average of two participants were interviewed daily and the implementation of protocols was done and analyzed immediately after each interview.

The convenience sampling method was used among the qualified participants in this study. By accepting the similarity of the individuals with each other in each group in terms of expertise and clinical experience, it seemed that each member of the research community could volunteer to participate in the study if they met the inclusion criteria.

Problem and scenario selection

To construct a suitable scenario for use as well as observe the considerations related to problem selection, the following criteria were considered:

1. According to the inquiry received from the Disaster and Emergency Management Center in Hormozgan province regarding the frequency of their missions in the recent year, two of the most common cases, namely, trauma cases and cardiovascular cases, were selected [Appendix 1]. Next, scenarios were designed based on these cases.
2. The complexity of the scenarios should be moderate to high because the study of the clinical reasoning process in all spectrums of expertise is considered.
3. It is possible to reach a diagnosis using different approaches to clinical reasoning, including analytical (such as hypothetico-deductive) and nonanalytical (such as pattern recognition).

Based on these criteria, the researchers conducted an extensive search in reputed EMS journals and websites and then selected the appropriate cases from "Prehospitalresearch.eu." Next, to obtain more information about these cases during a meeting, they consulted two emergency medicine specialists about the level of difficulty of the cases, as well as other information that they could enter regarding the final diagnosis in the scenarios. After obtaining the necessary information, finally, the scenarios were compiled.

To rectify any deficiencies in the designed scenarios, two interviews were first conducted with two technicians (a novice and an expert), who were asked whether the cases presented were unusual or difficult. The answer to this question was negative. As a result, the cases were not unusually complex. Next, the scenarios were finalized according to the opinions obtained from them. The scenarios used in the present study were finally translated into Persian and made available to the individuals.

The process of evaluating script-based clinical reasoning

Think aloud method

In this study, to collect and analyze participants' mental script-based information, the "think aloud" (TA) method was used, which is one of the most effective methods to evaluate and explain mental processes at high levels of cognitive area, such as problem-solving and reasoning.[26,27] Doing this type of process requires the involvement of active memory, the content of which can be verbalized. The output of this part of memory that is generated by the interviewee while solving the problem is called the "protocol," which can be analyzed to achieve the process of thinking at this time. It can also compare the thinking process of different individuals or groups while reasoning about a common issue.[5,26] Figure 1 shows how to extract a person's mental process using the TA method.[25]

Data gathering

The stage of gathering information by the TA method consists of two substages, "readiness" and "execution." The first step is to pay attention to the points that prepare people to participate in this method. It should be noted that TA is unusual compared to other methods of data collection.[25] The preparation phase is important because it brings the interviewer and the participant closer to a common understanding of how to gather information.

The second subphase includes interviewing and recording information. After structured interviews with each person, the text of the interviews is transcribed and it enters the content analysis stage as a raw protocol.

Content analysis

In analyzing the protocols extracted from the interviews, two main steps are considered as follows:

Step 1 - Preparing a suitable map to compare the protocol with the base pattern

Protocol analysis is a process that consists of different components and steps. Having an analysis map can not only show the necessary steps of analysis, but also provide information about what a researcher needs to analyze the protocol, thus informing the researcher about the prerequisites of the analysis process. Figure 2 is a sample of a protocol analysis map that was used in the current study.[28]

The psychological model is considered as the base model with which the protocol is compared after coding. The present study used the "illness script strategy" adapted from the script theory, which is also known as the pattern recognition strategy. This pattern includes the components of Enabling conditions, Pathophysiologic factors, Management, Diagnosis, and Signs and Symptoms.[2,29] According to the script strategy pattern, gaining experience and increasing professional years, in some components such as Signs and Symptoms, Pathophysiologic, and Diagnosis, shows a decrease, and in the components Enabling conditions and Management, it should show an increase. That is, experts present fewer signs and symptoms during clinical reasoning, refer less to physiopathologic analysis, and make fewer differential diagnoses.

Step 2 – Quantifying the relationship between the protocol and the base pattern

The two main aims of this method are to objectify the degree of compliance of the protocol with the base model and to compare the protocols obtained from the two groups with each other. For this purpose, first, the recorded statements of each participant while thinking were transcribed.

The transcribed text, called the raw protocol, was examined and analyzed, and in each of the texts, predicted coded protocols were extracted and counted. In this study, they were selected according to the script or pattern recognition strategy. Then, the components of each segmented protocol were examined for similarity with the defined codes in the clinical script model. If each component of the protocol was similar to one of these codes, it was labeled with the same code name. In this method, the presence or absence of that code was considered, so that at the end of the analytical result of each protocol was a table that indicated the number of labels of each protocol according to each of the defined codes.

Since each protocol had several codes (components of the script) based on the expertise level, it was possible to quantitatively compare the average number of each component of the script in the total number of individuals assigned to the novice group with the average of same part of the script in the expert group.

In this stage, to reduce possible errors and biases in preparing the coding scheme as well as the coding process, we involved three experts in the clinical reasoning field.

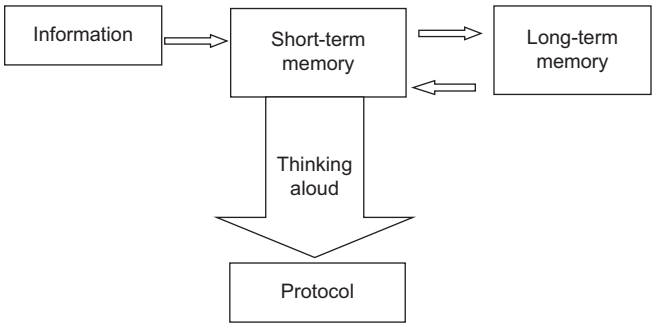

Figure 1: Creating protocol by think aloud method

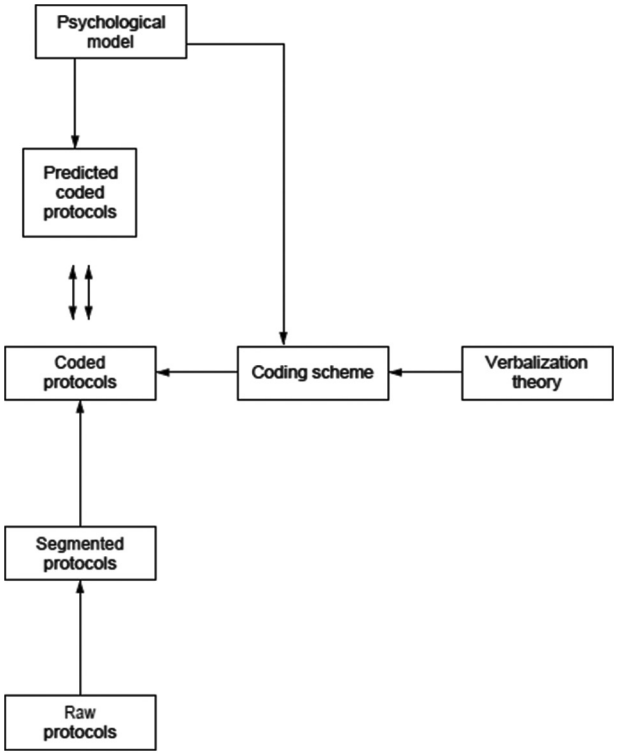

Figure 2: Steps of protocol analysis in think aloud method

Statistical analysis

In this study, the Shapiro–Wilk test was used to evaluate the data distribution normality due to the relatively small sample size. According to the result of the test, all data had a normal distribution. Then, an independent *t*-test was used to compare the average number of each component of the clinical script content between the expert and novice groups. The significance level was considered less than 0.05 ($P \leq 0.05$). For the statistical analysis phase, the Statistical Package for the Social Sciences (SPSS)-21 software was used.

Ethical considerations

This study was approved by the Research Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran (ethical code: IR.SBMU.SME.REC.1398.009). The privacy of people was protected. Also, consent was obtained from all participants before they were involved in this study.

Results

Participants

A total of 19 male EMTs participated in this study, which included two groups of novices and experts from different five urban emergency stations. Table 1 shows the characteristics of EMTs.

Similarity of the clinical scripts of the two groups with the expert panel

The results of this comparison are shown in Table 2. The degree of similarity between the components of the clinical script of the two groups and the expert panel showed there was more similarity between the expert EMTs and the expert panel. It also indicated the degree of accuracy diagnosis by under-study groups as well.

This similarity or accuracy of diagnosis in the components of Enabling (E), Pathophysiology (P), Management (M), Diagnosis (D), and Signs and Symptoms (S) related to the experts' group was 20%, 30%, 2%, 28%, and 27% more than the novices' group, respectively.

On the other hand, a new component called "Contextual insight" (C) was extracted from the clinical scripts of both groups. The expert group was 27% more similar to the expert panel than the novice group in this component as well.

One of the findings according to Table 2 is the degree of similarity related to the "Diagnosis" component in the two groups of experts and novice (80% and 78%, respectively), which is different from the expertise assumptions based on the clinical script model.

Table 1: Characteristics of participants

Group	Work experience	Average age	Center name (urban)	Number of participants	Total (gender)
Expert	>10 years	30 years	A	1	7 (m)
			B	2	
			C	2	
			D	1	
			E	1	
Novice	<1 year	24 years	A	3	12 (m)
			B	2	
			C	1	
			D	3	
			E	3	

M=male, A=Central, B=Golshahr, C=Imam Hussein, D=Islam Abad, E=Saheli

Table 2: Comparison of the accuracy of the diagnosis of the mental script of EMTs in terms of the similarity of script components with the expert panel

Components Groups	E (%)	P (%)	D (%)	M (%)	S (%)	C (%)
Expert	60	40	80	82	75	62
Novice	40	10	78	54	48	35

EMTs=emergency medical technicians, E=Enabling conditions, P=Pathophysiology, D=Diagnosis, M=Management, S=Signs and Symptoms, C=Contextual insight

Comparison of the components of the clinical script in the two groups

After transcribing the participants' mental data and accessing the protocols, each of the resulting protocols was analyzed using a coding guide that resulted from the content model of the clinical script.

In the analysis of protocols, the emphasis was on labeling the mental contents of each individual in such a way that eventually, all the semantic units of the protocols as one of the sections of Enabling conditions, Pathophysiologic factors, Management, Diagnosis, Signs and Symptoms, and also a new component called Contextual insight (if available) were marked. In the end, the average number of each component of the clinical script in the expert and novice groups was compared using an independent *t*-test. The results of comparing each of the components of the clinical script content in the two groups are presented in Table 3.

According to Table 3, the average number of using Enabling conditions in the two groups of experts and novices was 14.6 and 8.15, respectively, and this difference was significant ($P = 0.002$). The average number of uses of Signs and Symptoms in the expert and novice groups was 10.33 and 5.38, respectively. Also, this difference was significant ($P = 0.004$).

The average number of uses of Management component in the expert and novice groups was 19.68 and 9,

Table 3: The components of the mental script of EMTs according to the level of expertise

Components of script	Groups (novice/expert)	Mean (SD)	*P*
Enabling conditions	N	8.15 (3.62)	0.002
	E	14.6 (8.01)	
Signs/Symptoms	N	5.38 (4.38)	0.004
	E	10.33 (5.03)	
Physiopathology factors	N	0.85 (1.67)	0.720
	E	1.04 (1.3)	
Diagnosis	N	2.08 (1.38)	0.936
	E	2.04 (1.2)	
Management	N	9 (4.96)	<0.001
	E	19.68 (10.44)	
Contextual insight	N	0.15 (0.37)	<0.001
	E	7.6 (7.25)	

E=Expert, N=Novice, EMTs=Emergency medical technicians

respectively, and the difference between these two means was estimated to be significant ($P < 0.001$). The average number of uses of Contextual insight component in the expert and novice groups was 7.6 and 0.15, respectively, and the difference between these two means was also significant ($P < 0.001$).

Discussion

This study aimed to clarify the script-based clinical reasoning process in EMTs. First, an expert panel was employed to ensure the accuracy of the methodology of differentiation between novice and expert EMTs. As we expected, the results showed the similarity of script components of the expert group with the expert panel in the same scenarios.

The most important results of comparing components of the illness script pattern in the two groups of novice and expert are presented as follows.

Enabling conditions and Management components

Transcription of the interview text and its analysis and then quantification of findings showed that this component of the illness script pattern is also generalized to EMTs. Also, the significance of the comparison results in the two groups indicated that the experts with increasing experience and who are present in the workplace pay more attention to the Enabling conditions.

Similar conditions were observed for the Management component when expert EMTs were compared to novice technicians, due to their increasing experience and professional background in the management of patients under their treatment, as they have more skills.

The results observed in these two components have been emphasized in Keemink *et al.*'s study[30] that developed illness scripts in preclinical education through case-based clinical reasoning training, as well as in the study of Van Schaik *et al*.[31] that was performed to evaluate the influence of illness script components and medical practice on medical decision-making. Also, these studies are significantly consistent with each other in terms of the results. Keemink *et al.* and Van Schaik *et al*.[30,31] have pointed out that experts, due to the increasing experience in components related to the Enabling conditions and Management, have more skills than novices. They emphasized the more prominent role of experience in increasing these two skills in the expert group.

Pathophysiology and Diagnosis components

Comparing these two components of the illness script of the novices and experts showed that these two groups were not significantly different in terms of pathophysiology and diagnosis. In other words, the role of experience was not able to differentiate the experts' group from the novices' group.

These findings, in addition to not following the illness script pattern, also were in contradiction to the results of a qualitative study by Vreugdenhil *et al*.[32] that was conducted to explore the possible extension of the illness script theory used in medicine to the nursing context. They reported that experts, as a result of gaining experience over the years, paid less attention to physiopathologic factors and also made fewer diagnoses. The results of the present study did not find significant differences in these two components.

Analysis of the findings related to these two components in EMTs can be sought in the functional nature of this field. Diagnosis and treatment are separate from their performance. They need to simulate the patient's signs and symptoms and the initial conditions observed at the scene for those responsible for the final diagnosis and treatment. So, EMTs are sensitive to the fact that when referring a patient to the hospital treatment team, they always point out all pathophysiologic cases and possible diagnoses. In other words, it shows the skill of creating a mental connection between the two factors as well. Although these are in contradiction to the primary pattern of the illness script, the nature of the prehospital field is more visible due to the intermediate strength of the EMTs and can suggest a different aspect of this pattern.

Signs and Symptoms component

An interesting, special, and different point that was obtained in this study is related to the Signs and Symptoms component of the illness script pattern. It showed experts referred to more signs and symptoms, and this was significantly different from the classic pattern of illness script in physicians, nurses, and so on. In addition, this finding was unlike those reported in

other studies such as the study of Custers *et al*.,[33] which described the role of illness scripts in the development of medical diagnostic expertise, as well as the study of Custers[34] that explained the introduction and spread of the concept of "illness script" in the medical education literature.

This can also be attributed to the nature of this field. The experts try to report all the signs and symptoms observed at the time of the accident during the transfer of the patient to the final therapist, like what they observed when facing the scene. This is part of their professional skills and requirements. Therefore, at the time of the interview, expert technicians subconsciously tried to express more signs and symptoms.

Contextual insight component

One of the highlights of this study, which is specific to EMTs, is the knowledge of some items outside of patients' medical affairs, which we called the Contextual insight. It includes legal cases, social responsibilities, ethical considerations, issues related to the custom of the community, psychological support, risk management on the scene, human principles, and others, which were clearly and very significantly higher in the experts than the novices. This means that the role of experience in gaining contextual insight and gaining knowledge from patients' nontherapeutic conditions in the prehospital settings is very important. Therefore, this can also be considered as a new component in this model.

Limitation and recommendation

This project was a pilot study of the application of thinking aloud to determine script-based clinical reasoning in EMTs. The results of this study need to be confirmed with a larger sample. In the future, other variables may be included in extensive studies, including more training–operational levels related to EMT group and different operating environments (air, marine, or ground ambulances) as well as conducting studies at different universities.

Conclusion

EMTs, as the leading force and the front line of treatment in the prehospital situation, play a pivotal role in the management and treatment chain of emergency patients. Understanding the mechanisms of clinical reasoning in this health-care provider group is necessary.

The results of studying concordance of the script-based clinical reasoning of the under-study groups with the base pattern showed that in some components of the pattern they practiced as in other medical groups. In contrast, in some components, due to the different nature of the prehospital conditions, they did not follow this pattern or practiced the exact opposite. The special conditions of this profession also showed the need to add new components to this base model, which should be considered in distinguishing between expert and novice EMTs.

Acknowledgements

This study is part of the first author's Ph.D. dissertation at Shahid Beheshti University of Medical Sciences (SBUMS). We are grateful to SBUMS for their support. Also, we are sincerely thankful to all people who participated in this study.

Financial support and sponsorship

Funding for this study was provided by SBUMS, Tehran, Iran (grant number: 98-15876).

Conflicts of interest

There are no conflicts of interest.

References

1. Shin HS. Reasoning processes in clinical reasoning: From the perspective of cognitive psychology. Korean J Med Educ 2019;31:299-308.
2. Delavari S, Monajemi A, Baradaran HR, Myint PK, Yaghmaei M, Soltani Arabshahi SK. How to develop clinical reasoning in medical students and interns based on illness script theory: An experimental study. Med J Islam Repub Iran 2020;34:9.
3. Moghadami M, Amini M, Moghadami M, Dalal B, Charlin B. Teaching clinical reasoning to undergraduate medical students by illness script method: A randomized controlled trial. BMC Med Educ 2021;21:87.
4. Si J. Strategies for developing pre-clinical medical students' clinical reasoning based on illness script formation: A systematic review. Korean J Med Educ 2022;34:49-61.
5. Boushehri E, Monajemi A, Arabshahi KS. Key feature, clinical reasoning problem. Puzzle and scenario writing: Are there any differences between them in evaluating clinical reasoning. Trends Med 2019;19:1-7.
6. Salkowski LR, Russ R. Cognitive processing differences of experts and novices when correlating anatomy and cross-sectional imaging. J Med Imaging (Bellingham) 2018;5:031411.
7. Yazdani S, Hoseini-Abardeh M. Clinical reasoning in medicine: A concept analysis. J Med Edu 2017;16:e105581.
8. Altalhi F, Altalhi A, Magliah Z, Abushal Z, Althaqafi A, Falemban A, *et al*. Development and evaluation of clinical reasoning using 'think aloud' approach in pharmacy undergraduates-A mixed-methods study. Saudi Pharm J 2021;29:1250-7.
9. Brentnall J, Thackray D, Judd B. Evaluating the clinical reasoning of student health professionals in placement and simulation settings: A systematic review. Int J Environ Res Public Health 2022;19:936.
10. Aein F, Hosseini R, Naseh L, Safdari F, Banaian S. The effect of problem-solving-based interprofessional learning on critical thinking and satisfaction with learning of nursing and midwifery students. J Educ Health Promot 2020;9:109.
11. Parandavar N, Rezaee R, Mosallanejad L, Mosallanejad Z. Designing a blended training program and its effects on clinical practice and clinical reasoning in midwifery students. J Educ Health Promot 2019;8:131.
12. Forsberg E, Georg C, Ziegert K, Fors U. Virtual patients for assessment of clinical reasoning in nursing -- A pilot study. Nurse

Educ Today 2011;31:757-62.
13. Kim JY, Kim EJ. Effects of simulation on nursing students' knowledge, clinical reasoning, and self-confidence: A quasi-experimental study. Korean J Adult Nurs 2015;27:604-11.
14. Koharchik L, Caputi L, Robb M, Culleiton AL. Fostering clinical reasoning in nursing students. Am J Nurs 2015;115:58-61.
15. Koivisto JM, Multisilta J, Niemi H, Katajisto J, Eriksson E. Learning by playing: A cross-sectional descriptive study of nursing students' experiences of learning clinical reasoning. Nurse Educ Today 2016;45:22-8.
16. Watkins S. Effective decision-making: Applying the theories to nursing practice. Br J Nurs 2020;29:98-101.
17. Clemett VJ, Raleigh M. The validity and reliability of clinical judgement and decision-making skills assessment in nursing: A systematic literature review. Nurse Educ Today 2021;102:104885.
18. Hagiwara M. Development and Evaluation of a Computerised Decision Support System for use in pre-hospital care: Högskolan i Jönköping, Hälsohögskolan, HHJ: School of Health Sciences; 2014.
19. Andersson U, Maurin Söderholm H, Wireklint Sundström B, Andersson Hagiwara M, Andersson H. Clinical reasoning in the emergency medical services: An integrative review. Scand J Trauma Resusc Emerg Med 2019;27:76.
20. Muecke S, Curac N, Binks D. Informing clinical policy decision-making practices in ambulance services. Int J Evid Based Healthc 2013;11:299-304.
21. Royce CS, Hayes MM, Schwartzstein RM. Teaching critical thinking: A case for instruction in cognitive biases to reduce diagnostic errors and improve patient safety. Acad Med 2019;94:187-94.
22. Newgard CD, Nelson MJ, Kampp M, Saha S, Zive D, Schmidt T, *et al*. Out-of-hospital decision making and factors influencing the regional distribution of injured patients in a trauma system. J Trauma 2011;70:1345-53.
23. Abetz JW, Olaussen A, Jennings PA, Smit V, Mitra B. Review article: Pre-hospital provider clinical judgement upon arrival to the emergency department: A systematic review and meta-analysis. Emerg Med Australas 2020;32:17-23.
24. Kilner T. Triage decisions of prehospital emergency health care providers, using a multiple casualty scenario paper exercise. Emerg Med J 2002;19:348-53.
25. Aitken LM, Mardegan KJ. "Thinking aloud": Data collection in the natural setting. West J Nurs Res 2000;22:841-53.
26. Lundgrén-Laine H, Salanterä S. Think-aloud technique and protocol analysis in clinical decision-making research. Qual Health Res 2010;20:565-75.
27. Wolcott MD, Lobczowski NG. Using cognitive interviews and think-aloud protocols to understand thought processes. Curr Pharm Teach Learn 2021;13:181-8.
28. Van Someren M, Barnard YF, Sandberg J. The Think Aloud Method: A Practical Approach to Modelling Cognitive Processes. London: Academic Press; 1994. p. 118.
29. Monajemi A. Clinical Reasoning: Concepts, Education and Assessment. Esfahan, Iran: Esfahan University of Medical Science Publication; 2010.
30. Keemink Y, Custers E, van Dijk S, Ten Cate O. Illness script development in pre-clinical education through case-based clinical reasoning training. Int J Med Educ 2018;9:35-41.
31. van Schaik P, Flynn D, van Wersch A, Douglass A, Cann P. Influence of illness script components and medical practice on medical decision making. J Exp Psychol Appl 2005;11:187-99.
32. Vreugdenhil J, Döpp D, Custers E, Reinders ME, Dobber J, Kusukar RA. Illness scripts in nursing: Directed content analysis. J Adv Nurs 2022;78:201-10.
33. Custers EJFM, Boshuizen HPA, Schmidt HG. The role of illness scripts in the development of medical diagnostic expertise: Results from an interview study. Cognition and Instruction 1998 (Published online: 14 Dec 2009);16:367-98.
34. Custers EJ. Thirty years of illness scripts: Theoretical origins and practical applications. Med Teach 2015;37:457-62.

Appendix 1

Scenario 1: Trauma case

CASE NO 1: HEAD TRAUMA

Patient & Apparent Chief Complaint

A 68-year-old male presents to ambulance crew through emergency call after falling from his bicycle at an unknown speed.

History

Patient was cycling on quiet country road when he fell from his bicycle. He was not wearing a helmet at the time. His friend found him semi-conscious on the road. He was placed sitting in a car that stopped to help where he was still sitting on arrival of ambulance crew.

Initial Clinical Findings

Airway – partially obstructed, large amounts of vomit evident
C Spine – suspected (MOI: fall, altered LOC)
Breathing – regular
Circulation – Pulse present, regular, skin color pale, cap refill delayed (>2 sec)
Disability – LOC before ambulance arrival; patient experiencing periods of lucidity, alternating with responding to voice

Clinical Impression

Head injury secondary to fall

AMPLE History

A No known allergies
M Currently taking ant-hypertensive medications
P History of hypertension, investigated for right sided weakness 2/52 previous to event
L Last oral intake lunch earlier that day
E Found semi-conscious on road after fall from bike, no evidence of collision with vehicle

Observations – Prehospital

Pulse rate 58 bpm
Pulse rhythm Regular
ECG rate 58
ECG rhythm Sinus bradycardia
Resp rate 20 per min, normal, regular
Resp quality Equal air entry bilaterally
SaO2% 99% on 15lpm via NRB
Cap refill >2 s
BP 136/101
Pupils Left size 3, reactive. Right unreactive (damaged in surgery)
GCS 15/15 (E4, V5, M6)
BGL 7.1 mmol/l

Prehospital care and management

O_2 @ 15lpm commenced via non-rebreather mask. Cervical collar applied. Patient extricated from vehicle via rapid extrication, as vomiting profusely, unable to manage airway adequately. Secured to longboard, transferred to ambulance. Suction provided as patient's level of consciousness began to deteriorate, snoring respirations evident. Enroute, GCS reduced to 3/15, patient unresponsive. OPA inserted, not tolerated. Vomiting profusely, incontinent of urine, decorticate posturing evident. Transported in right lateral position to allow for airway management. On arrival at ED, patient exhibited decerebrate posturing.

Identification of all interventions initiated and rationale

- Oropharyngeal airway – to protect the airway due to decreased level of consciousness
- Suction – to clear the airway of vomit due to patient's inability to maintain own airway
- Pulse oximetry – to monitor oxygen saturation levels in the blood
- Supplemental oxygen – to re-oxygenate patient
- Cervical collar and longboard – to provide support and protection to the cervical spine due to serious mechanism of injury suggestive of spinal injury
- Three-lead ECG – to identify any life-threatening arrhythmias
- 12-Lead ECG – to identify any life-threatening arrhythmias or ECG changes indicative of myocardial damage (primary cause of fall, secondary to hypoxia, etc.)

Scenario 2: Cardiovascular case

CASE NO. 2: HEART DISEASE

Patient and Apparent Chief Complaint

A 46-year-old male presents to the ambulance crew with central crushing chest pain, radiating to his shoulder blades.

History

This gentleman was packing golf clubs into his car with two friends present when he developed sudden crushing pain in his chest, radiating to his shoulder blades. Pain 9/10 on scale. He had no previous medical history of significance, a nonsmoker and nondrinker. Ambulance was called for by one of his friends. No first aid was administered.

Initial Clinical Findings

Airway – clear
C Spine – not indicated (NOI: chest pain)
Breathing – adequate
Circulation – Pulse present, irregular; skin color pale, cap refill normal
Disability – Patient alert and orientated, PEARRL

Clinical Impression

Cardiac chest pain, acute myocardial infarction

AMPLE History

A NKDA
M No medications
P Nil medical history of significance
L Breakfast at 09:30 (fruit)
E Packing car when pain occurred

Observations

Pulse rate 100 bpm
Pulse rhythm Irregular, weak, and thready
ECG rate 108
ECG rhythm Sinus tachycardia with ST elevation in antero-septal leads (V1–V4)
Resp rate 18
Resp quality Shallow and labored in both lungs. No wheeze/crackles
SpO_2% 99% on O_2 @ 15lpm; 89% on room air
Cap refill <2 s
BP 115/78
Pupils PEARRL, size 4
GCS 15/15 (E4, V5, M6)
BGL 5.8mmol/l
Temp 35.2°C
Physical examination Nil of significance, nil pedal edema. Patient diaphoretic and anxious

Prehospital care and management

O_2 @ 15lpm via NRB commenced by Paramedic crew. GTN 800 mcg administered sublingually. Aspirin 300 mg PO administered. Morphine 10 mg IV administered in 2 mg doses, 3 min apart. Clopidogrel 300 mg PO administered.

Identification of all interventions initiated and rationale

- Pulse oximetry – to monitor oxygen saturation levels in the blood
- Supplemental oxygen – to re-oxygenate patient and increase potential oxygen supply to the myocardium
- GTN – to reduce preload and in turn reduce myocardial oxygen demand
- Aspirin – to decrease the risk of further clots developing and causing further myocardial damage
- Semi-recumbent position – comfortable for patients with chest pain, allows for relaxation of abdominal muscles, and allows for use of intercostal muscles of the back to aid breathing
- Three-Lead ECG – to identify any life-threatening arrhythmias
- 12-Lead ECG – to identify any life-threatening arrhythmias or ECG changes indicative of myocardial damage (secondary to hypoxia, etc.)
- Morphine – to relieve pain due to cardiac ischemia and to reduce anxiety
- Clopidogrel – to further reduce the risk of clot formation
- Thrombolysis – to dissolve any clot that may be present in the coronary arteries, causing myocardial ischemia