Review Article

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The effects of simulation training on learning of health information systems: A scoping review

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Abstract:

One of the most commonly used methods for training is simulation. It is important to examine the effects of simulation training of health information systems on the knowledge, attitude, and skill in trainees. This review provided a summary of relevant literature on how simulation training affects the learning of health information systems and determine the features and functional capabilities of existing simulators. Studies and websites using simulation training to teach health information systems were included. Studies were searched through Medline (via PubMed), Scopus, and ISI Web of Science and websites through Google search by the end of 2019. The characteristics of studies, features, and functional capabilities of simulators and effects on learning outcomes were extracted. The included studies and websites were categorized according to different characteristics including simulation types, learning outcome categories, and the effects of simulation training on learning outcomes. The learning outcomes were categorized into four groups: knowledge, attitude, skill, and satisfaction. The effects of interventions on outcomes were categorized into statistically significant positive, positive without statistical argument, no effect (not statistically significant), negative without statistical argument, or statistically significant negative. Ten studies and eight websites that used simulation training to teach health information systems (mainly electronic health record [EHR]) were included. EHR simulation was performed in 80% of the included studies and trainees in 70% of studies were physicians and nurses. All studies were conducted in three developed countries. In the included studies, four learning outcomes (i.e. skill, attitude, knowledge, and satisfaction) were assessed. Ninety percent of the included studies assessed skill-related outcomes, with more than half mentioning significant improvement. Thirty percent of the included studies assessed outcomes-related knowledge and attitude, all of which reported the positive effects of simulation training. The simulators offered a variety of functional capabilities, while all of which simulated the clinical data entry process. In teaching health information systems, especially EHRs, simulation training enhances skill, attitude, knowledge, and satisfaction of health-care providers and students.

Keywords:

Computer user training, electronic health record, health information systems, simulation training

Introduction

Nowadays, information systems are widely used in health-care settings and have the potential to improve the efficiency, effectiveness, and quality of health-care services as well as patient satisfaction.[1] The most popular health-care information systems are electronic health records (EHR) and electronic medical records (EMRs). EHR and EMR, in addition to the above benefits, can reduce medical errors and improve patient safety.[1,2] However, the gaining benefits of these systems highly depend on the skills of health-care providers to meaningfully use them. Training plays an important role in enhancing the ability of health-care providers to use and apply such systems

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meaningfully and effectively. Effective training can lead to successful implementation and users' acceptance of information systems.[3-5]

So far, several approaches have been proposed for EHR and EMR training.[6] One of the most commonly used methods is simulation training. Simulation training provides trainees with the opportunity to practice consciously, with specific learning goals and immediate feedback on their performance, before actual engagement in the real clinical environment.[7] Simulation training can reduce cognitive errors related to improper use of EHR.[8,9] In a simulated environment, trainees can be trained without compromising patient safety and confidentiality of patient information.[10] Studies showed that the use of simulation in clinical skills education has positive outcomes.[11,12]

Numerous studies have investigated the impact of using simulated health information systems on improving the related learning outcomes. A study carried out by Smith and Scholtz[13] demonstrated that the use of simulation training can improve students' acceptance and readiness to use EHR. According to Haugen,[14] the acceptance rate of EMR for the providers using simulation training was 70% higher than those had used traditional training approaches. In their study, George *et al*.[15] stated that simulation training can significantly increase the speed and accuracy of using health information systems among users.

Knowledge, attitude, and skill are important learning outcomes, and appropriate training should lead to improve these outcomes in trainees. For this reason, it is important to examine the effects of simulation training of health information systems on the knowledge, attitude, and skill of trainees. To our knowledge, there is no systematic review on the effects of simulation training on learning outcomes regarding health information systems. Moreover, there is no evidence to indicate the features and functional capabilities of simulators for teaching health information systems. One systematic review in 2018 conducted on simulation of health information systems.[16] This review study revealed several important themes related to using clinical simulations with educational EHRs. The themes that emerged during this review include the following: properties of ideal educational EHRs; benefits and disadvantages of using educational EHRs; facilitators and barriers for implementing educational EHRs; best practices for incorporating educational EHRs into preexisting educational simulations, and importance of educational EHR simulation training. This review study however did not report the effects of simulation training of health information systems on learning outcome.[16]

Objective

Our objective was to present a summary of relevant literature on the effects of simulation training of health information systems on the knowledge, skill, and attitude of trainees, as well as to determine the features and functional capabilities of existing health information systems simulators.

Materials and Methods

Data sources and search strategies

We searched Medline (through PubMed), Scopus, ISI Web of Science by using the keywords and MeSH terms related to health information systems (e.g. EHR, EMR, and EHR), and simulation training (e.g. simulation training, learning, and computer simulation) (the details of the search strategy are provided in Appendix). The searches focused on papers published by the end of 2019 and the language were English. Websites were searched through Google search engine using the above-mentioned keywords.

Inclusion and exclusion criteria

Inclusion criteria

Studies were included that used simulated health information systems such as EHR and EMR for training, trainees were students or health-care providers and assessed the effects of simulation training on trainees' knowledge, attitude, skill, or satisfaction. Furthermore, websites that were designed to simulate one of the health information systems for training purposes were included.

Exclusion criteria

Studies that reported only simulation training but did not assess its effects on trainees' knowledge, attitude, or skill and also studies that trained health information systems in clinical settings without any simulation were excluded.

Screening and data extraction

The title, abstract, and full text of the papers were independently reviewed by two Researchers E.N and F.Gh). The information extracted from the papers were authors' names, publication data, country, participants (trainees), type of intervention, measured outcomes, and the effects of intervention on learning outcomes. The information extracted from the websites were name, URL, trainees, method and cost of access, functional and nonfunctional capabilities of simulators, and user comments on the experience of working with simulators. Functional capabilities were defined as requirements that describe what the system should do. These requirements describe in detail the functions of the system, and its inputs and outputs. Nonfunctional capabilities are a set of constraints on

services or functions provided by the information system.[17]

Data synthesis and analysis

Meta-analysis was not appropriate due to the heterogeneity of the included studies in method, results and statistical analysis. The characteristics of the included studies and websites were reported, separately. The included studies were categorized according to different characteristics including simulation types, learning outcome categories, and the impact of simulation training on outcomes. The learning outcomes were categorized into four groups: knowledge, attitude, skill, and satisfaction. Similar to the study by Nabovati *et al*.,[18] the effects of interventions on outcomes were categorized into statistically significant positive, positive without statistical argument, no effect (not statistically significant), negative without statistical argument, or statistically significant negative. Websites were categorized according to accessibility, simulated processes, functional and nonfunctional capabilities, and a group of system trainees.

Results

The search results are shown in Figure 1. The database search led to 2746 papers. A total of 26 papers were selected based on the inclusion criteria. After reviewing the full text of the papers, 11 papers from 10 studies were selected based on the inclusion criteria. In the case of websites, with the first 1000 search results in Google search, eight websites were selected based on the inclusion criteria.

Characteristics of the included studies

Table 1 presents eight studies (80%) were conducted in the US, two others in the UK and Canada. All the included studies were published in 2014 onwards. One study was randomized controlled trial[19] while the others were quasi-experimental. One study simulated the Electronic Patient Record.[20] Seven studies simulated the EHR and the other two studies simulated EMR.[21,22] Participants in most studies (70%) were physicians and nurses. Most studies (90%) examined participants' skill in working with health information systems.

Characteristics of the included websites

Table 2 shows the trainees of the websites were nurses and physicians, and one website in addition to nurses and physicians introduced users of health information management as system trainees. Only two simulators (25%) were available for free (VistaA and OpenEMR). Websites offered different functionalities, but all supported the clinical data entry process. Furthermore, six websites (75%) simulated the admission and discharge process, and four websites (50%)

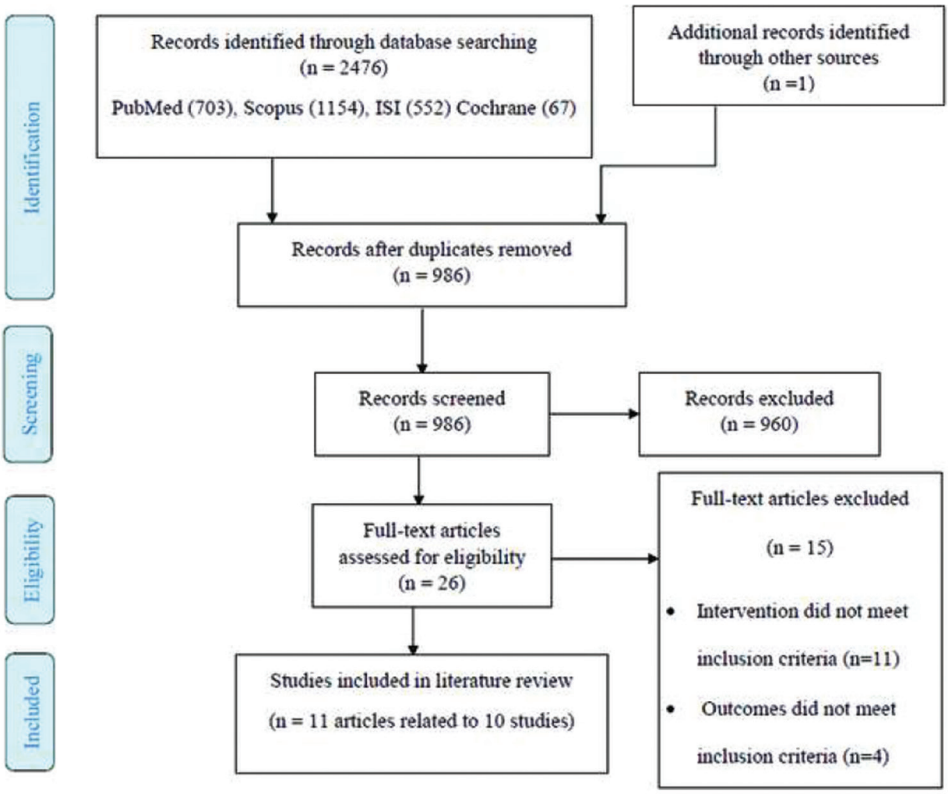

Figure 1: Flow diagram of the literature search and study selection

Table 1: Main characteristics of the included studies (ranked according to year of publication)

Authors (year), Country	Purpose	Study type	Intervention	Participants, practice	Outcome(s)	Results	Conclusion
Coons *et al*., (2018),[19] the USA	To evaluate the impact of a virtual EHR and patient simulation on learning efficiency and student perception of their learning	RCT	Virtual EHR (DocuCare®, Lippincott Williams and Wilkins)	All 115 students enrolled into the required pharmacotherapy of cardiovascular diseases course (2015-16 academic year) There were five to six students in each group	Time required to provide the most optimal recommendation (s) for each patient scenario Student perception of their learning (clinical skills, communication skills, and satisfaction)	Use of the virtual EHR decreased the amount of time needed to provide the optimal treatment recommendations by 25% compared to the control 95% of students agreed or strongly agreed that the use of the EHR contributed positively to their learning and enabled them to efficiently learn new and challenging concepts. The virtual EHR improved domains related to perceptions of clinical skills, attitudes of ownership, and communication compared to baseline (P<0.001)	The virtual EHR demonstrated value in learning efficiency while providing students with an engaging means of practicing essential pharmacist functions in a simulated setting
Smith and Scholtz (2018),[13] the USA	To evaluate the impact of a simulated EHR on student performance and to describe students' perceptions of preparedness to use an EHR in clinical practice	Quasi-experimental (posttest-only design with nonequivalent groups)	A simulated EHR (NiaRx System)	3rd year pharmacy students Intervention group (class of 2016): 182 students Control group (class of 2015): 181 students	Students' performance Students' perceived level of preparedness to use an EHR	No significant difference between groups on student performance (P=0.522) Statistically significant improvements in students' perceptions of preparedness to use an EHR	Implementation of a simulated EHR did not show a difference in student performance, but did show improvements in students' perceptions of preparedness to use an EHR in clinical practice

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Authors (year), Country	Purpose	Study type	Intervention	Participants, practice	Outcome(s)	Results	Conclusion
Elliott *et al*., (2018),[20] the UK	To capture students' experiences of the EPR simulation	Quasi-experimental (one-group posttest-only)	EPR mobile application simulation that included Clinical notes Patient's details Vital signs Progress report Drug chart	296, 3rd year student nurses	Student engagement with the EPR simulation Value and impact of the EPR simulation	Student engagement with the various components was good, especially with regard to developing skill in using specific components of the EPR such as using clinical notes, patient details, vital signs and progress report The students were positive about the value and impact of the activity on their learning how to use EPRs. The components of the EPR that were valued most by students were the clinical notes about the patient, the quality of patient information provided, the ease of entering data, and the ability to track data	The study showed that the students were very positive about the EPR app and they were able to use the app successfully in simulation. The findings suggest that there is a need to incorporate EPRs into nursing education programmers
Zoghbi *et al*., (2018),[21] the USA	To evaluate the effects of videos about EMR tasks on resident efficiency and confidence in performing essential perioperative tasks	Quasi-experimental (one-group pretest-posttest)	Videos on 7 key perioperative EMR tasks	Eleven surgery interns (2016 academic year)	Working time with EMR Confidence in performing EMR tasks Average clinical scores The ability to perform EMR tasks	All the interns' times in seconds were statistically significant after watching the videos and performing the simulated emergencies ($P<0.05$) Interns self-reported improved confidence. These results were statistically significant in 5 of 7 EMR tasks ($P<0.05$). Participants demonstrated a significant improvement in average clinical scores on the emergency simulations ($P<0.05$) All 11 interns were able to complete all tasks	This study demonstrates that brief videos on key perioperative EMR tasks and simulations are promising tools to increase interns' ability and confidence in completing these tasks. This just-in-time educational intervention could improve workflow efficiency and enhances clinical performance, both of which may ultimately enhance perioperative patient safety

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Authors (year), Country	Purpose	Study type	Intervention	Participants, practice	Outcome(s)	Results	Conclusion
George *et al*., (2016),[15] the USA	To investigate the impact of using a simulated EHR during high-fidelity human simulation	Quasi-experimental (one-group pretest-posttest)	A simulated HER (Neehr perfect)	A sample of 44 junior-level, pre-licensure, nursing students	Navigation time to complete an EHR Accuracy to complete an EHR	Navigation time improved significantly (P<0.0001) Accuracy improved but not statistically significant (P=0.141)	Integration of a simulated EHR into high-fidelity simulation improves student speed while maintaining accuracy in the utilization of health care technologies
Shachak *et al*., (2015),[22] Canada	To evaluate a prototype computer-based simulation to teach residents how to integrate better EMR use in the patient-physician interaction	Quasi-experimental (one-group pretest-posttest)	A simulated EMR	16 family medicine residents	Competencies related to the use of the EMR in the consultation Attitudes related to the use of the EMR in the consultation Acceptability of the simulation	Improved significantly from 14.88±2.63 before to 15.63±2.80 after using the simulation prototypes Increased from 22.25±2.44 before to 23.13±2 after using the simulation prototypes but not significantly Scores for perceived ease of use and perceived usefulness were good (4.10±0.73 and 3.81±0.74)	The study suggests that computer-based simulation may be an effective and acceptable tool for teaching family medicine residents how to better use the EMR in the consultation

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Authors (year), Country	Purpose	Study type	Intervention	Participants, practice	Outcome(s)	Results	Conclusion
Vuk *et al*., (2015),[23] the USA	To examine whether simulation training enhanced self-efficacy of physicians and nurses to use EMRs, and whether the training changed their perceptions about the importance of EMRs in helping patients and improving safety	Quasi-experimental (one-group pretest-posttest)	A simulated HER (epic systems)	293 physicians and 94 nurses who worked in outpatient clinics where a new EMR was implemented	Confidence level Preparedness levels Self-efficacy Importance of EMRs in helping patients Effectiveness of EMRs to improve patients' safety	Statistically significant increase in the overall confidence level for physicians and nurses ($P<0.05$) Statistically significant increase in the overall preparedness levels for physicians and nurses ($P<0.05$) The overall self-efficacy of physicians and nurses to use EMRs increased after simulation training as compared to before-simulation training Physicians' high ratings (5-6) slightly decreased after simulation training; nurses' high ratings (5-6) almost stayed the same High ratings (5-6) of nurses increased more than high ratings of physicians after simulation training	Simulation training enhanced physicians' and nurses' level of self-confidence and preparedness to use EMRs. To train health care providers how to use EMRs, simulation training should be considered as an interactive and effective method of teaching prior to implementation of EMRs in medical institutions

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Authors (year), Country	Purpose	Study type	Intervention	Participants, practice	Outcome(s)	Results	Conclusion
Rubbelke, *et al*., (2014),[24] the USA	To evaluate ease of use and student acceptance of Google drive to create an interactive simulated EHR	Quasi-experimental (one-group posttest)	A simulated EHR Included Vital sign Physician order Nurse note MAR Lab	Nursing students (sample size not mentioned)	The opinion of the professors about the simulator The student's opinion about the simulator	Faculty members have agreed that the simulated EHR is easy to set up for repeated simulations throughout the day. By adding a simulated EHR, students are able to incorporate documentation into their nursing care during the simulation experience, therefore enhancing organizational, time management, and critical thinking skills Students have adapted easily, and through discussion, they report similarities to what is experienced in the clinical setting	Students enjoy the ability to document during the simulation experience and appreciate not having the burden of additional expenses. Faculty members are content with the system and enjoy the ability to work with a familiar product. During discussions, they have stated that the system is easy to use and appreciate the ability to review documentation during debriefing
Milano, *et al*., (2014),[25] the USA	To develop and implement a simulated-EHR and to evaluated its educational effectiveness	Quasi-experimental (one-group posttest)	A simulated EHR Included A virtual patient's Outpatient Emergency Consultation notes Medication list Laboratory Imaging pathology results	129 third-year medical students and 12 internal medicine interns	Educational effectiveness of simulated EHR	About half (51%) of the students and almost all (92%) of the interns rated the activity as "effective" or "very effective;" the remaining 49% of students were evenly split between ratings of "neutral" and "ineffective"	The simulated EHR has a wide range of potential applications in clinical environments. The simulated EHR is a way to reinforce, in a safe learning environment, important behaviors required for maintaining a well-organized chart that reflects current standards for chronic disease and routine prevention

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Table 1: Contd...

Authors (year), Country	Purpose	Study type	Intervention	Participants, practice	Outcome(s)	Results	Conclusion
Borycki *et al*., (2014),[26] USA	To determine the effects of hands-on exposure to an HER upon undergraduate health informatics student competency development	Quasi-experimental (one-group pretest-posttest)	EHR educational portal	Students enrolled in a mandatory 3rd-year course in the undergraduate health informatics program Participants prior to hands-on use of the EHR=17 After EHR use=22	Health informatics competencies (information management, clinical/health sciences, the Canadian health care system, and the management sciences)	Statistically significantly higher ratings ($P<0.05$) on 10 out of the 18 (56%) health informatics competency measures	The study shows that hands-on exposure to an EHR as a new addition to a course can lead to statistically significant improvements in student competency development in 10 health professional competency areas. Students became more sensitive to the ability of the EHRs to reduce medical errors and redundancy of information while improving healthcare organizational efficiency

MAR=Medication administration record, EMR=Electronic medical records, EHR=Electronic health record, RCT=Root canal treatment, EPR=Electronic patient record

simulated the process of clinical data management and administration. Four websites (50%) listed users' opinions on using simulator software, all of them considered simulator as an effective training tool to improve the quality of learning.

Interventions description

The simulators in two studies[15,19] used two included websites in this study (DocUcare, NEEHR) [Table 2]. One study[23] used Epic EMR and another study[13] used NiaRx software for training, and two other studies[22,26] did not provide specifications of the simulation systems.

The effects of simulation training on learning outcomes

The categorization of outcomes and the impact of simulation training are shown in Table 3. Nine studies (90%) covered the outcomes related to skill, three studies (30%) covered the outcomes related to knowledge, four studies (40%) covered the outcomes related to attitude, and one study covered the outcomes related to participants' satisfaction. All studies indicated the positive impact of simulation training on learning outcomes of health information systems. Most studies (90%) examined the outcomes related to skill, where more than half of them (55%) significantly have been improved. Thirty percent of the included studies examined knowledge and attitude, all of them reported the positive effects of simulation training.

Discussion

This study reviewed ten evaluation studies and eight websites that attempted to simulate health information systems to train health-care providers or students. This study examined four learning outcomes (i.e. skill, attitude, knowledge, and satisfaction) in the included studies, all of which demonstrated a positive impact of simulation training on those outcomes. EHR simulation was performed in 80% of the included studies and participants in 70% of studies were physicians and nurses. All studies were conducted in developed countries. Websites offered different functionalities, but all education the clinical data entry process.

Most of the included studies have examined the skill-related outcomes, indicating the increasing the work skill with health information systems through simulation-based training. The effects of simulation training were reported positive in all the studies that examined this outcome. The importance of skill is that insufficient work skill with information systems may lead to poor adoption of this systems on the part of

Table 2: Characteristics of websites that provide health information system simulator

Software name	Website	Trainee	Access method	Functional features	Nonfunctional features	User comments
Sim EMR	https://v2.simemr.com	Doctors and nurses	Verification method through purchasing license	Data entry Clinical data Care plans Progress notes Consults Nurses notes Provider order History and Physical Process Nutritional services Patient registration Discharge Surgery Medication management MAR Results reporting Imaging radiology Lab results	Interactive Access via smartphone and PC Cloud-based (accessible and secure) User-friendly design Multidisciplinary usage avoids learner limitations Customizable medication formulary Powerful integration	According to users, software has increased the quality of training
Sim chart	https://evolve.elsevier.com/education/simulations	Nurses Medical office	Verification method through purchasing license	Data entry Clinical data Care plans Progress notes Consults Nurses notes Provider order History and Physical Process Nutritional services Patient registration Discharge Surgery Medication management MAR Results reporting Imaging radiology Laboratory results	Training videos Access through smartphone and PC Implementation manual Evaluation and reporting tools	The software has increased student skills in Documenting and working with EHR
EHR tutor	http://www.ehrtutor.com	Doctors and nurses	Verification method through purchasing license	Create patient charts during or after clinical rotations Data entry Clinical data Nurses notes Provider order and more	Works on tablets, iPhone, and android devices Easy grading Prebuilt template patients included	Not mentioned
Med affinity	www.medaffinity.com	Doctors and nurses	Verification method through purchasing license	Process Patient registration Discharge Data entry Clinical data Provider order Medication management MAR Data	Live scenario editing Import scenarios	Students were satisfied with the software

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Table 2: Contd...

Software name	Website	Trainee	Access method	Functional features	Nonfunctional features	User comments
VistA	http://worldvista.org	Doctors and nurses	Free access	Data entry Clinical data Financial-administrative data Process Admission		Not mentioned
Open EMR	https://www.open-emr.org/	Doctors and nurses	Free access	Data entry Clinical data Management Financial-administrative data Process Patient registration Discharge		Not mentioned
DocUcare	http://thepoint.lww.com	Nursing Medical education Health professions	Verification method through purchasing license 62-300$	Data entry Clinical data Management Financial-Administrative data Process Patient registration Discharge		Students were satisfied with the software
NEEHR	https://ehrgo.com	Nursing Doctors HIM Medical offices	Verification method through purchasing license 45-285$	Data entry Clinical data Management Financial-Administrative data Process Patient registration Discharge	Use any where Flexible scenarios Interactive Flexible documentation	Not mentioned
Total		Nursing=8 Doctors=7 HIM=1 Medical Offices=2	Free access=2 Purchasing license=6	Data entry=8 Management Financial-Administrative data=4 Patient registration=6 Discharge=6	-	-

MAR=Medication administration record, EMR=Electronic medical records, EHR=Electronic health record, HIM=Health information management, PC=Personal computer

health-care providers and this can lead to unsuccessful implementation of these systems.[27] The Quality and Safety Education for Nurses argue that the five competencies needed for nurses depend information technology skill.[28] Inadequate expertise of health-care providers in working with information systems can lead to poor or improper use of these systems and even incidence of medical errors.[29,30] Simulating health information systems can be a great strategy to enhance the skill of health-care providers in operating the information systems and increasing acceptance by users.

Approximately one-third of the included studies assessed the attitude-related outcomes, and all of which reported the positive effects of simulation training. It is critical to assess the outcome of attitude because it is an important factor in the proper and efficient use of information technology in health care.[31] A positive attitude toward information systems improve the efficiency, effective use, and satisfaction of users.[32,33] This review of studies indicated that simulation training improve users' attitude toward health information systems.

Approximately one-third of the included studies examined the outcomes related to knowledge. These studies reported the positive effect of simulation training on users' knowledge of health information systems. Health-care providers need sufficient knowledge of the capabilities and features of these systems to effectively and meaningfully use them.[34] The knowledge can improve the attitude and increase acceptance of health information systems among users.[35] The included studies in this review suggest that simulation can increase users' knowledge about the use of health information systems.

Most of the included studies in this review attempted to simulate EHR. EHR is one of the most important systems of health information technology.[36] EHR training is important because it has been increasingly implemented

Table 3: The categories of simulation outcomes and effects

Outcome category	Outcomes	Effect				Number of studies
		Positive effect			No effect	
		Statistically significant	Not stated about significance	Not statistically Significant		
Skill	Working time with a system	15,21				7
	Clinical skill	19				
	Competencies related to using the EMR	22				
	Preparedness to use an EHR	23	13,20			
	Students' performance		12			
	Accuracy to complete an EHR		25	15		
	Health informatics competencies	26				
Knowledge	Efficiency of learning	19	20			3
	Knowledge of EHR		13,20			
	Educational effectiveness		25			
Attitude	Confidence level	21,23				5
	Importance of EMRs in helping patients		23			
	Effectiveness of EMRs to improve patients' safety		23			
	Student's opinion and professors about the simulator		24			
	Attitudes related to using the EMR			22		
Satisfaction	Satisfaction	19				1
Number of studies		6	5	2	-	-

EMR=Electronic medical records, EHR=Electronic health record

over the last two decades,[37] and many current care providers lack enough ability to use health information systems.[38-42] Therefore, health-care providers need to gain the skill, knowledge, and in-depth understanding of EHR to make effective use of its functionalities.[34] The included studies suggest that the use of simulation training can affect the ability of health-care providers to use EHR.

In most of the included studies, the trainees were nurses and physicians. Nurses and physicians are among the main health-care providers that produce and record the largest volume of clinical data. Studies have shown that physicians' adoption and use of health information systems leave an impact on the acceptance by other health-care workers.[43-45] One of the most important reasons for the poor adoption of information systems by nurses is inadequate training.[35] This review shows that the simulation training can provide physicians and nurses with the necessary training to interact with health information systems.

All the included studies were conducted in three developed countries. These developed countries are pioneers in applying health information systems, especially EHR. Another reason for not using simulation training to teach health information systems in other countries could be the operational issues. Among the issues of using simulation training are the financial costs of designing and implementing a simulator. The implementation of simulators involves a time-consuming process requiring the continued use of IT staff for initial implementation, continuous maintenance, and technical support.[16]

All of the reviewed websites educate the clinical data entry. The training of clinical data entry into health information systems is important since health-care providers spend a significant portion of time on this activity. Several studies have reported that time-consuming data entry into information systems are the most important reason for physicians' dissatisfaction with these systems.[46,47] Studies have shown that physicians working with EHR were concerned about the time needed to perform the necessary activities and record data.[48,49]

Overall, the results of the included studies show that simulation training provides an ideal method for training health information systems, particularly EHR. Simulation training can enhance users' knowledge, skill, and attitude on health information systems and lead to satisfaction in using these systems. Simulation is selected as a method for training information systems owing to its various benefits, such as reducing cognitive errors related to misuse of information systems, creating a realistic environment where users can be trained without compromising patient safety and upgrading skill. Promoted information skill of users is the other advantage of applying a simulator in training of health information systems[8] According to Reis *et al*.,[50] simulation training improves physicians and patients computer communication skills. In other study, the authors concluded that the use of EHRs in clinical simulations improve the recognition of

patient safety issues that are identifiable from the EHR notes.[51] Frenzel[52] concluded that pharmacy students were satisfied with simulation training using EHRs and this learning method improved the effectiveness of training.

Strengths and limitations

To the best of our knowledge, this is the first review study to investigate the effects of health information systems training through simulation. However, there are several limitations in this review. Some related studies may have been missed due to the exclusion of non-English language publications. The significant heterogeneity between studies in terms of method and results prevented meta-analysis. Participants in the included studies mostly involved physicians and nurses, and the results may not be generalizable to other health-care providers.

Implication for future research

It is recommended that future studies concentrate on the costs involved in the implementation of training simulators, determining the standard (technical and content) characteristics of training simulators and the impact of the simulator on the acceptance of these systems among users.

Implication for practice

The results of this study demonstrated that using simulation to train health information systems increases the skill, attitude, knowledge, and satisfaction of students and health-care providers. Based on these results, it is recommended that universities, health-care settings, and institutions developing and implementing health information systems use this method to train users effectively and integrate this method into the curriculum. In critical situations where it is not possible for trainees to be present in the hospital (for example, a pandemic), the simulation method can be effective.

Conclusion

In teaching health information systems, especially EHRs, simulation training improves the skill, attitude, knowledge, and satisfaction of students and health-care providers including physicians and nurses. Future studies are recommended to examine the effects of simulation training on the acceptance of health information systems among users.

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Conflicts of interest

There are no conflicts of interest.

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