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Teaching Clinical Decision-Making Skills to Undergraduate Nursing Students via Web-based Virtual Patients during the COVID-19 Pandemic: A New Approach to The CyberPatient™ Simulator

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Abstract

Objective: The aim of this study was to investigate the effects of using a virtual patient simulator on the acquisition of clinical decision-making skills in nursing students during the pandemic COVID-19.

Methods: This was a quasi-experimental study with a pretest-posttest design. Following the case-based learning strategy, the educational intervention was designed and implemented in five steps (pre-activities, introduction, scenario briefing, web-based clinical scenarios, presentation and de-briefing). We assessed clinical decision-making skills of nursing students before the intervention, after the intervention, and 1 months later, with Clinical Decision-Making questionnaire. In this study SPSS software version 23.0 was used to analyze the data and significance level was considered $P < 0.05$.

Results: Clinical decision-making skills of nursing students was compared before (48/04 ± 12/77) and immediately after training (91/49 ± 7/66) using paired tests, and a statistically significant difference was found ($P = 0/009$). Also, before the intervention, most students were thinking analytically (63/80%) and making clinical decisions, while after the intervention, most students had an analytic-intuitive model of clinical decision-making (63/80%).

Conclusion: The study showed that the decision-making skills of nursing students were significantly improved by virtual patient simulations. The educational intervention and simulator used in this study can be integrated into undergraduate nursing student education curricula to help them acquire clinical decision-making skills.

Keywords: Nursing students, clinical decision-making, simulation education, virtual simulation, skill

Introduction

One of the most important aspects of nursing education is teaching clinical decision-making skills.[1] Because of the complexity of the legal and professional issues they face today, nursing students must acquire sufficient skills to make clinical decisions during their education.[2] Furthermore, the ability to diagnose and treat patients quickly and accurately is not a skill that can only be learned theoretically.[3] Currently, after training courses and before students enter the practical stage and deal directly with patients, they teach them how to diagnose disease quickly, make the right decision, take action accordingly, and deal with patients professionally.[4–5] For this purpose, considering the achievements of technology, it is recommended to do planning so that it can be integrated into the clinical education curriculum.[6] In this regard, technology has been used in nursing education for years to enhance teaching and learning.[7]

In the meanwhile, due to the increasing incidence and prevalence of COVID-19 worldwide and in Iran since the beginning of the twentieth century, all clinical rotations and training opportunities have been suspended to reduce the burden of the disease.[8–9] A major challenge in the current situation is how to continue medical education when there is no direct contact with patients.[9] In order to solve this challenge, we need to pay more attention to the capabilities of technology in clinical education. The use of simulation-based learning platforms began before COVID-19, but the pandemic has also led to an increase in the demand for and use of alternate, innovative methods for training nurses.[10]

Several research studies on integrating technology into clinical education suggest that simulation-based learning can help nursing students develop their clinical decision-making skills in complex situations.[11] These patients are based on a scientifically problem-based design and structure that mimics the various stages of dealing with real patients, beginning with the initial interview and continuing through treatment.[12] Real emergency patients need to be treated immediately. In these situations, patient care is a priority that cannot be postponed for the student's presence. In this situation, the student is in a passive and observational role and does not make decisions.[13] While by working with a virtual patient, the student has the opportunity to work with severe, abnormal, and critical patients. The student has the opportunity to work with patients who have complex physical and mental conditions, make mistakes, then receive feedback and reapply the correct method. During virtual patient simulations, time and urgency constraints are controlled. In other words, time pressure can be removed when the student needs to concentrate.[14]

Research has shown that simulation-based education not only improves students' mental abilities, including their clinical reasoning skills, but also positively affects their attitudes.[15] In addition, this method has a significant impact on students' acquisition of skills in the application of techniques. As a result, nursing educators are increasingly incorporating virtual simulations into their curricula.[16]

In the field of clinical education, there are many simulated environments designed to enhance students' scientific and practical skills and prepare them for real-life situations.[17] Despite the numerous technology-based programs for clinical education, there are few computer programs that can simulate the realism of the doctor-patient relationship.[15] One of the simulators currently being used in clinical education is the CP-platform developed by the Department of Surgery at the College of British Columbia. CP has managed to accomplish this task and make this long-standing dream of instructors and students a reality.[18]

The philosophy behind CP-platform is that traditional medical education starts with etiology and pathogenesis and then moves on to signs and symptoms of the disease. But in real cases, the patient goes to the doctor with the chief complaint, and the doctor has to think backward after examining the signs and symptoms to find out the cause and pathogenesis of the disease. This difference has led to many challenges being encountered by trainees, doctors, and novice nurses in attempting to apply theoretical knowledge in practice. This is one of the reasons why medical and nursing schools have moved to a problem-solving, case-based curriculum. These changes brought a number of challenges and issues including patient availability, the need to increase the number of clinical faculty, and ultimately an increase in the cost of medical education. Consequently, the centralized use of computers may be the solution to the challenges associated with a problem- or case-based curriculum.[19]

The CP interactive learning system is based on problem solving and clinical decision making. In the system, students gather information with menus that include laboratory results, clinical examination of the patient, and diagnosis and treatment of the patient's condition. Students can also select cases of increasing difficulty so they can work on more advanced aspects of diagnosis and treatment for that particular condition each time.[19] The results of the study conducted by Farahmand et al. (2020) show that the use of CP virtual patient simulator has been effective in enhancing students' history taking skill, increasing the effectiveness of clinical education and reducing costs.[20]

There is limited evidence that simulation can be an effective teaching and learning tool for clinical decision making. However, no study to date has measured the impact of cyberpatient simulation on students' clinical decision-making skills. Therefore, the present study investigated the impact of using this virtual patient simulator on the acquisition of clinical decision-making skills by nursing students at Shahid Beheshti University of Medical Sciences (SBMU) in Iran.

Theoretical Framework

The National League for Nursing Jeffries Simulation Theory[21] was combined with International Nursing Association for Clinical Simulation and Learning (INACSL) Standards of Best Practice (SOBP)[22] to form the theoretical basis for this study. Simulation activities are designed, implemented, and evaluated using concepts laid out in Jeffries' NLN theory. This theory focuses on context, background, design, simulation experiences, facilitators and educators, participants, and outcomes. As outlined in the INACSL SOBP, a valid and rigorous simulation experience requires well-defined and content-aligned outcomes, qualified faculty, adequate student preparation, theory-based debriefing, and curriculum integration.[21,23]

Materials and Methods

Study Design and Setting

This was a quasi-experimental study with a pretest-posttest design. It was conducted between 2020 and 2021 to evaluate the effectiveness of the CP training programme on the clinical decision-making skills of nursing students at SBMU.

Study Participants and Sampling

All third-year nursing students who had completed their clerkship at the time of the study (n = 58) were selected by census method. The inclusion criteria for the present study were interest in participating in the research and completion of a course in medical-surgical nursing. Exclusion criteria for participants included refusal to proceed with the research, failure to attend an educational session, and failure to complete the research instruments in the second phase of data collection.

Ethical Consideration

Informed consent was obtained from all participants. They were assured that their personal information would be kept confidential and only general statistics and data would be published. This project was conducted in the form of PhD student thesis and approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences (Ethics Code: IR.SBMU.SME.REC.1400.044) Address: https://ethics.research.ac.ir/EthicsProposalView.php?id = 213812.

Intervention

In a briefing session, students learned how to use the cyberpatient system and what is expected of them during the training process. The screen interface components and navigation boxes were described. Students were given 10 minutes to familiarize themselves with the software and completed the demographic information questionnaire and Clinical Decision-Making (CDM) instrument during this session.

Based on the educational strategy of case-based learning, the educational intervention was designed and implemented in five steps (pre-activities, introduction, scenario briefing, Web-based clinical scenarios, presentation and de-briefing) (Figure 1).

1. Pre-activities

In accordance with the clinical course plan for cardiology diseases in nursing students' internships, eight cardiovascular disease case studies were selected from the CP case library (Figure 2-1). The cases were placed in the virtual classroom dashboard in the CP system for students to access. The educational intervention was conducted in the university clinical laboratory for eight weeks. Students participated in a clinical exercise each week under the supervision of a clinical professor and worked on a clinical case. For each case, the following steps were completed in order.

2. Introduction

A clinical instructor discussed the educational goals to be achieved after working with the virtual patient (Figure 2-2).

He also asked questions to inquire about the all-encompassing prior knowledge relevant to the case.

3. Scenario Briefing

Students began working with the virtual patient after the clinical professor briefly introduced the case.

4. Clinical Scenarios Presentation

We scheduled and conducted a one-hour session with the virtual patient each time, beginning with the students logging into the simulator (https://app.cyberpatient.ca) until the system provided feedback (Figure 1). Users accessed the system using their assigned usernames and passwords. Once the student logged in, the virtual patient became available. After interviewing, examining the virtual patient's body systems, gathering information, and reviewing lab test requests related to the patient, the student moved on to the diagnosis phase and selected an appropriate treatment based on their diagnosis. This phase ended with the simulator providing feedback to the student on his actions during the history taking, physical examination, diagnosis, and treatment phases.

By selecting the case on the screen, the virtual patient was presented in this simulated environment. Text, images, videos, and animations were used in an interactive virtual patient experience. This system allowed the student to enter a question and ask it to a virtual patient. The software then searched for the keyword in the question and returned an answer with voice and dialogue from the virtual patient (Figure 2-3). By clicking on the left side of the mouse, the user could explore the systems related to the patient's problem. In the toolbar of the software, there were a number of tools for monitoring and examining patients. If needed, the student could take a blood sample from a virtual patient, insert a nasal cannula, and take the patient's temperature and blood pressure with a thermometer and blood pressure monitor. Students were able to see step-by-step how to perform each of the required actions on the virtual patient (Figure 2-4).

Using the mouse, the student selected the part of the virtual patient to be examined and could then perform inspection, palpation, percussion, and auscultation. The physical examinations were simulated with software that allowed the user to listen to the lungs and decide for themselves whether the sounds were normal or not. The student was expected to make a possible diagnosis based on the data collected. Once the diagnosis was made, the student had to create a treatment plan for the patient. This system allows the student to prescribe medication for the patient. When prescribing the medication, the student should determine the name, method of administration, dosage, and number of daily doses. The student should create a follow-up plan and make

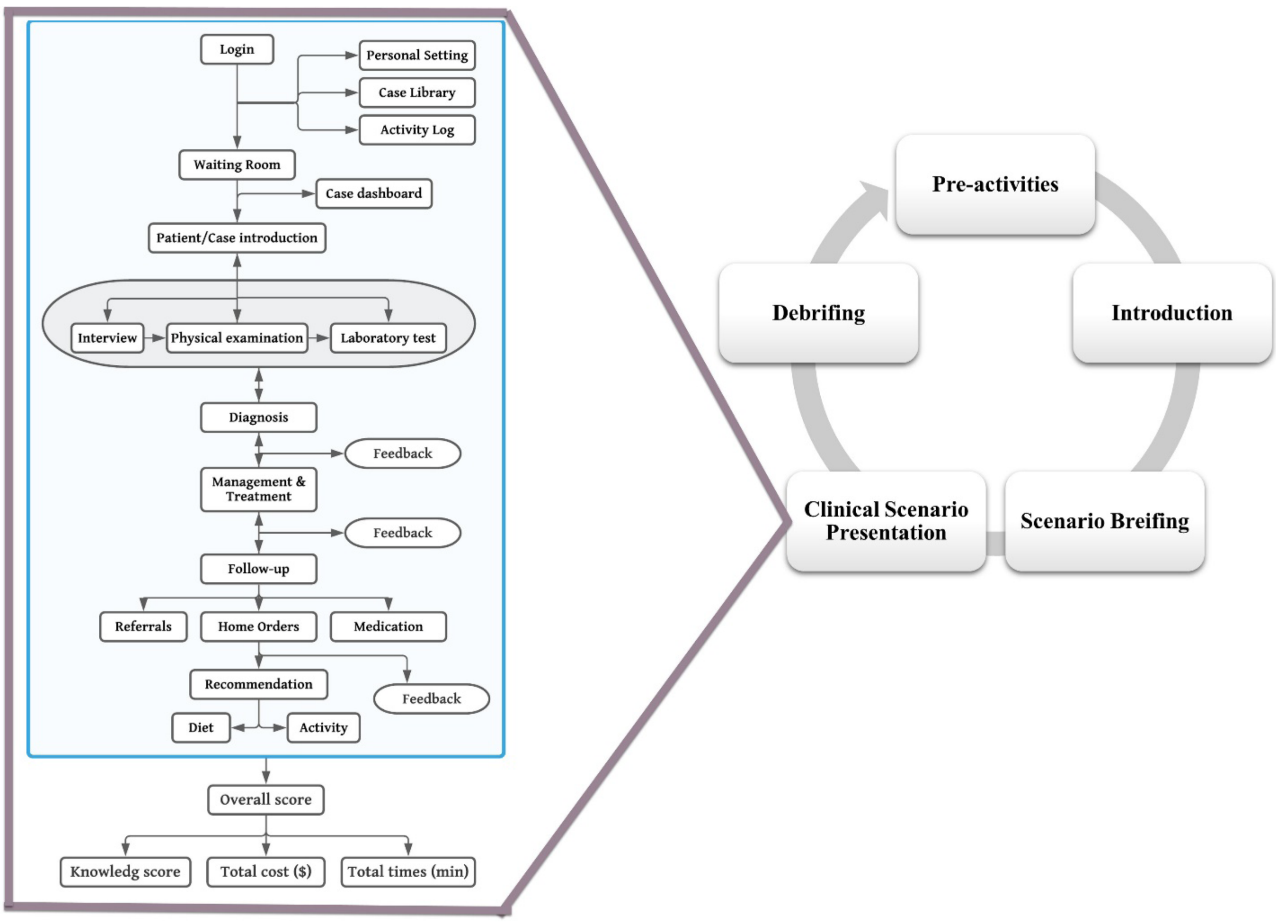

Fig. 1 **Cycle of simulation-based learning activities in the CP-based intervention. The clinical scenario presentation step was performed on the CyberPatient platform. In this figure you can see the main components of the platform. From the case dashboard (case encounter), the user can follow any path. It is also possible to return to the case presentation from the Diagnosis, Therapy or Follow-up sections.**

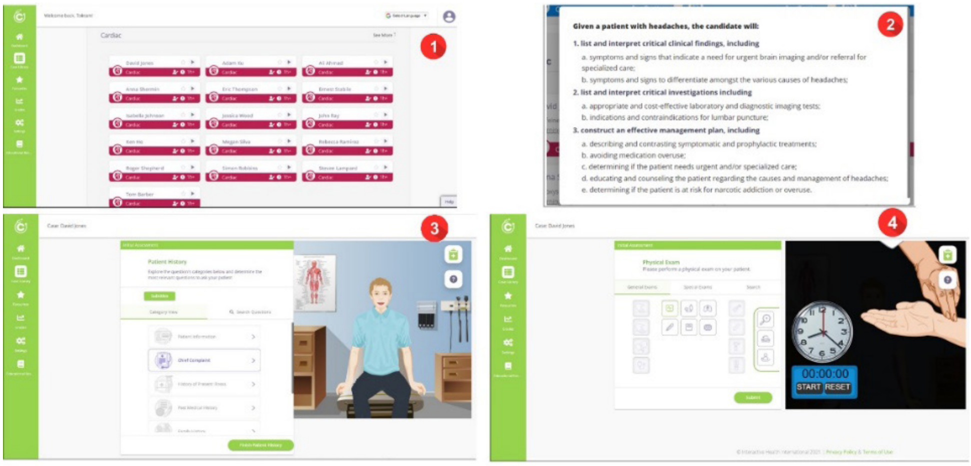

Fig. 2 **Screenshots of the CyberPatient Software.**

recommendations to improve the patient's lifestyle and diet after selecting the appropriate treatment for the patient. Using the CyberPatient simulator, the student could calculate the cost-effectiveness of diagnostic, therapeutic, and follow-up interventions. The software could also record the time spent on each case, the number of errors made and the immediate feedback received.

5. Debriefing

The students took part in a 90-minute debriefing session in the conference hall of Mofid Hospital in Tehran 24 hours after working with each virtual patient. The clinical professor had attended a debriefing training workshop to be able to conduct debriefing sessions and had the necessary expertise for that. In this study, the 3D model was used for debriefing, and all debriefing sessions were in compliance with INACSL standards.

Data Collection Tool and Technique

In this study, a demographic information questionnaire and Clinical Decision-Making (CDM) instrument by Lauri and Salantera (2002) were used to collect data. This 24-item instrument was divided into four subscales, each containing six items corresponding to the four steps of the decision-making process.

The CDM uses a 5-point Likert scale. The even-numbered items reflect decision making in situations with unpredictable outcomes, such as "I make assumptions about impending care problems when I first meet the patient." The odd items reflected decision making in structured tasks or in situations where there is sufficient time to gather information or plan activities, e.g., "Based on my preliminary information, I specify all the items I want to monitor and ask the patient about. According to the instructions, the total sum of the scores was interpreted." Responses are graded from never (1), rarely (2), sometimes (3), often (4), and almost always (5). Scores range from 120–24, with scores ranging from five (always) to one (never) for sentences with a positive semantic load and vice versa for expressions with a negative semantic load. Reversed expressions in this questionnaire are: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, and 23 (one = always, five = never). A score of 67 or less indicates systematic analytic decision making, a score between 68 and 78 indicates analytic intuitive decision making, and a score above 78 indicates intuitive interpretive clinical decision making.[22]

Internal Consistency Reliability

The reliability of the translated questionnaire was confirmed in the Javadi study (2008), and the internal correlation of Cronbach's alpha was reported to be 0.75.[24] The reliability of this instrument was re-assessed by Karimi Naghandar et al. (2013) and $\alpha = 0.85$ was reported.[25] In the present study, the reliability of this tool was evaluated by using the test-retest method on 20 people. Cronbach's alpha coefficient of 0.86 was calculated and reported.

Analysis

SPSS software version 23.0 was used to analyze the data and examine the effects of using the simulator on students' clinical decision-making skills. Shapirovilk and Kolmogorov-Spironov tests were used to examine the natural distribution of the quantitative variables. Descriptive statistics such as mean, standard deviation, and frequency distribution were used to describe the characteristics of the participants. Paired t-tests were used to compare the clinical decision-making score in the two phases before and after the intervention and to compare the score immediately after the intervention and one month after the intervention. Significance level was considered $P < 0.05$.

Results

Fifty-eight students in their third year of nursing studies participated in this study. The majority of participants were single (87.3%) and female (81.7%). The mean age of the participants was 21 ± 4.5 years. The majority of participants (86.2%) had never experienced virtual training or simulation in clinical education.

Clinical decision-making skills of nursing students was compared before (48/04 ± 12/77) and immediately after training (76/49 ± 7/66) using paired tests, and a statistically significant difference was found (P = 0/009). Students used analytic clinical decision-making before the intervention and intuitive clinical decision-making after the intervention. A statistical difference was also observed in clinical decision-making skills before and after one month of follow-up (P = 0/001). Comparison of clinical decision-making ability immediately after training with that after one month of follow-up (73/06 ± 4/9) also revealed no statistically significant difference (P = 0/235) (Table 1).

In addition, the results showed that 24.14% of nursing students used analytic-intuitive reasoning before the intervention. 70.69% of the respondents used analytical decision making while 5.17% used intuitive decision making. After the implementation of educational intervention based on virtual patient simulator, 25.86% students showed intuitive thinking, 63.80% showed analytical-intuitive thinking and 10.34% showed analytical thinking. Thus, it can be said that before the intervention, most students were thinking analytically and making clinical decisions, while after the intervention, most students had an analytic-intuitive model of clinical decision-making (Table 2).

Discussion

Accordingly, the current study, designed to examine the effects of virtual patient simulators on nursing students' clinical decision-making skills, showed a significant increase in their ability to make clinical decisions. In addition, the results showed that the durability of acquired clinical decision-making skills was significantly higher after one month of the intervention than before the intervention.

Numerous studies have examined how virtual patients and simulators affect students' clinical decision-making skills. As shown in a study by Nibbelink et al. (2018), computer software can provide unlimited opportunities for nursing student education by providing a safe and realistic environment in which they can practice clinical decision making and practical skills without potential risk to the patient.[26]

Consistent with the findings of the present study, Roh (2013) et al. conducted a comparative study to assess nurses' self-efficacy in cardiopulmonary resuscitation decision making using computer simulations and mannequin simulations. The study showed that computer simulations had a greater impact on nurses' clinical decision making.[27]

Endacott's (2012) study assessed nurses' clinical decision-making skills using standardized patients and mannequins in an OSCE test. According to the study, the use of standardized patient simulation methods helped to strengthen nurses' clinical decision-making skills more effectively than mannequins. In addition, simulation and informal feedback were used to improve clinical decision making in emergency situations.[28] After working with each virtual patient, we debriefed and then drew conclusions from each case. We then provided feedback to the student on how to improve their performance on the case.

As previously mentioned, 5.17% of the subjects used intuitive reasoning before the intervention and 25.86% after the intervention, which indicates that the use of the CP virtual patient simulator improved the use of intuitive clinical reasoning by nursing students. Non-analytical or intuitive reasoning occurs unconsciously and fast, it happens in the moment without much effort, and it doesn't require much energy. Pattern recognition is equivalent to analytical reasoning. In daily life, we do things that happen automatically over time without thinking about them. To understand these behaviors, we form cognitive structures in our minds called pattern recognition.[29]

Pattern recognition in medicine is divided into diseases. Based on pattern recognition theory, due to repeated exposure, an organized set of medical information imprints itself in their memory so that they use it when making decisions and solving problems with subsequent patients. Therefore, when experienced students are confronted with new disease cases that are similar to diseases they have previously encountered, they can quickly recall a structured network of relevant information and thus spend less time finding solutions (Okoli, 2018).[30] A CP simulator, as mentioned earlier, provides a successful solution to learning pattern recognition for any disease through continuous practice on a standard virtual patient. The nursing student, supported by his cognitive structures, can make a correct clinical decision in a situation similar to the virtual case.

In the present study, it was found that 70.69% of the subjects used analytical thinking before the intervention which decreased to 10.34% after the intervention. The study found that the number of students who used analytical-intuitive thinking increased after the intervention (63.80%). When a nursing student uses analytic or hypothetico-deductive reasoning, he or she attempts to make a possible diagnosis by establishing a causal relationship between signs and symptoms. It is a trial and error-based method. Students and novice nurses usually use this approach to solve clinical problems based on the pathophysiology of disease. The reason is that their information is insufficiently structured and they lack clinical experience in dealing with different types of patients.[31]

Therefore, it can be said that clinical reasoning is a spectrum that includes analytical reasoning or deductive hypotheses on one side and intuitive or non-analytical reasoning on the other. In general, the nursing student moves from analytical thinking on this side of the spectrum to intuitive thinking on the other side of the spectrum, gaining experience and

Table 1. **A Comparison of the scores in Pre-test and Post-tests (1 and 2) and the scores in Post-tests (1 and 2) in the CP-based intervention**

Group	Pre-test	Post-test 1	Post-test 2
CP-based training	48/04 ± 12/77	76/49 ± 7/66	73/06 ± 4/09
Paired test	**Pretest-Posttest 1**	**Pretest-Posttest 2**	**Posttest1-Posttest 2**
P value	P = 0/009	P = 0/001	P = 0/235

Table 2. **Classification of nursing students according to three clinical decision models before and after the intervention**

Decision-Making Model	Range of Score	Number Before intervention	Percent (%) Before intervention	Number Immediately after the intervention	Percent (%) Immediately after the intervention
Intuitive decision making	Above 78	3	5/17	15	25/86
Analytical-intuitive decision making	Between 78–68	14	24/14	37	63/80
Analytical decision making	Under 68	41	70/69	6	10/34

practice and repeating the clinical decision-making position. In the middle of this spectrum is analytic-intuitive reasoning.

Similarly, in study conducted by Şahin (2021), most of the participants reported that virtual patient simulation enabled them to apply theoretical knowledge in practice. Based on these results, simulation-based training and the use of visual technologies can facilitate the acquisition of nursing skills.[32] The results of this study are in agreement with Parker's study (2014). Parker's study found that nurses' decision-making progressed from intuitive to analytical through education.[33] Surgical students were taught surgical skills using virtual patients in Shariati's study (2008). Based on the results of this study, educating students based on virtual patients helps them to design a mental framework or pattern recognition to taking history of the patient. Thus, the student can use this same pattern recognition to taking history from almost all patients with similar complaints.[34]

Limitation and Recommendation

This study shows that using simulation to teach clinical skills is critical for a successful curriculum. The fact is that implementing such a curriculum is not always easy. Incorporating simulations into the curriculum remains a challenge, but it is important to note that they are most successful when they become a natural part of the curriculum rather than a separate component. The results of this study may not suggest that the improvement in students' clinical decision-making skills is simply due to working with the CP virtual patient simulation platform as a teaching tool, because it was used in a comprehensive clinical course with planned educational activities. On the other hand, building knowledge and acquiring process skills are also complicated.

The other limitations of this study include the small number of research units, implementation of this intervention in a group setting, lack of a control group to compare outcomes, and implementation in only one heart disease rotation. The educational intervention and simulator used in this study can be integrated into undergraduate nursing curricula to help students acquire clinical decision-making skills. In addition, it is proposed to evaluate the impact of using the CP virtual patient simulator and the educational design of this study on nursing students' critical thinking skills.

Conclusion

The review of the results shows that nursing students' clinical decision-making skills can be improved in a controlled environment using the CP simulator. Students can practice their skills in a safe environment without harming patients. The use of CP-based clinical simulation is a great way for nursing students to combine, relate, and ultimately apply their theoretical knowledge to nursing practice.

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Conflicting Interest Disclosure

CP is a business education product developed by the University of British Columbia / Vancouver Coastal Health (UBC / VCH) and Spin-off Company UBC / VCH. The University of British Columbia and the Virtual University of Medical Sciences, Tehran, Iran, have signed a Memorandum of Understanding granting all Iranian medical universities free access to this platform. Due to this probable conflict of interest, the study was organized and conducted by a research committee with no conflict of interest at Shahid Beheshti University of Medical Sciences.

References

1. Johnsen HM, Fossum M, Vivekananda-Schmidt P, Fruhling A, Slettebø Å. Teaching clinical reasoning and decision-making skills to nursing students: Design, development, and usability evaluation of a serious game. International journal of medical informatics. 2016 Oct 1; 94:39–48.
2. Ewertsson M, Bagga-Gupta S, Allvin R, Blomberg K. Tensions in learning professional identities–nursing students' narratives and participation in practical skills during their clinical practice: an ethnographic study. BMC nursing. 2017 Dec;16(1):1–8.
3. Levett-Jones T, Hoffman K, Dempsey J, Jeong SY, Noble D, Norton CA, Roche J, Hickey N. The 'five rights' of clinical reasoning: An educational model to enhance nursing students' ability to identify and manage clinically 'at risk' patients. Nurse education today. 2010 Aug 1;30(6):515–520.
4. Farzi S, Shahriari M, Farzi S. Exploring the challenges of clinical education in nursing and strategies to improve it: A qualitative study. Journal of education and health promotion. 2018;7:115–123.
5. Weller JM. Simulation in undergraduate medical education: bridging the gap between theory and practice. Medical education. 2004 Jan;38(1):32–8.
6. Guze PA. Using technology to meet the challenges of medical education. Transactions of the American clinical and climatological association. 2015; 126:260–270.
7. Wilkinson A, Roberts J, While A. Nursing students' use of technology enhanced learning: A longitudinal study. Journal of Nursing Education and Practice. 2013 May 1;3(5):102–115.
8. Sharma D, Bhaskar S. Addressing the Covid-19 burden on medical education and training: the role of telemedicine and tele-education during and beyond the pandemic. Frontiers in Public Health. 2020 Nov 27; 8:838–852.
9. Rezaei H, Haghdoost A, Javar HA, Dehnavieh R, Aramesh S, Dehgani N, Sisakht MT. The effect of coronavirus (COVID-19) pandemic on medical sciences education in Iran. Journal of Education and Health Promotion. 2021 Jan 1;10(1):136–144.
10. Tabatabai S. COVID-19 impact and virtual medical education. Journal of Advances in Medical Education & Professionalism. 2020 Jul 1;8(3): 140–3.
11. Foronda CL, Fernandez-Burgos M, Nadeau C, Kelley CN, Henry MN. Virtual simulation in nursing education: a systematic review spanning 1996 to 2018. Simulation in Healthcare. 2020 Feb 1;15(1):46–54.
12. Elcokany NM, Abdelhafez AI, Samuel Sharaby VM, Belal S. Use of Computer-Based Scenarios for Clinical Teaching: Impact on Nursing Students' Decision-Making Skills. InHealthcare. 2021 Sep; 9 (9): 1228–1240.
13. Zary N, Johnson G, Boberg J, Fors UG. Development, implementation and pilot evaluation of a Web-based Virtual Patient Case Simulation environment–Web-SP. BMC Medical Education. 2006 Dec;6(1):1–7.
14. Berman NB, Durning SJ, Fischer MR, Huwendiek S, Triola MM. The role for virtual patients in the future of medical education. Academic medicine. 2016 Sep 1;91(9):1217–22.
15. Liaw SY, Siau C, Zhou WT, Lau TC. Interprofessional simulation-based education program: A promising approach for changing stereotypes and improving attitudes toward nurse–physician collaboration. Applied Nursing Research. 2014 Nov 1;27(4):258–60.
16. Mohamed SA, Fashafsheh IH. The effect of simulation-based training on nursing students' communication skill, self-efficacy and clinical competence for nursing practice. Open Journal of Nursing. 2019 Aug 22; 9(8):855–70.

17. Isaza-Restrepo A, Gómez MT, Cifuentes G, Argüello A. The virtual patient as a learning tool: a mixed quantitative qualitative study. BMC Medical Education. 2018 Dec;18(1):1–10.
18. Kurihara Y, Kuramoto S, Matsuura K, Miki Y, Oda K, Seo H, Watabe T, Qayumi AK. Academic performance and comparative effectiveness of computer- and textbook-based self-instruction. InMEDINFO 2004 (pp. 894–897). IOS Press.
19. Qayumi AK, Qayumi T. Computer-Assisted Learning: cyberPatient™-A Step in the Future of Surgical Education. Journal of investigative Surgery. 1999 Jan 1;12(6):307–17.
20. Farahmand S, Meneghetti A, Shi K, Pachev G, Ramezani J, Zeinoddini S, et al. CyberPatient™—An Innovative Approach to Medical Education. Creative Education. 2020; 11, 926–941.
21. Rutherford-Hemming T, Lioce L, Jeffries PR, Sittner B. After the national council of state boards of nursing simulation study—Recommendations and next steps. Clinical Simulation in Nursing. 2016 Jan 1;12(1):2–7.
22. Lauri S, Salanterä S, Chalmers K, Ekman SL, Kim HS, Käppeli S, MacLeod M. An exploratory study of clinical decision-making in five countries. Journal of Nursing Scholarship. 2001 Mar;33(1):83–90.
23. INACSL Standards Committee. INACSL standards of best practice: SimulationSM simulation design. Clinical Simulation in Nursing. 2015; 12, S5–S12.
24. Javadi N, Paryad A, Fadakar K, Roshan Z, Asiri Sh. Clinical decision making: its relation with critical thinking. Journal of Gilan Nursing and Midwifery School. 2008; 18(60): 9–16 [Persian].
25. Karimi Noghondar M, Rahnama Rahsepar F, Golafrooz M, Mohsenpour M. Comparison of Critical Thinking and Clinical Decision-Making Skills Among the Last-Semester Nursing Students and Practicing Nurses in Sabzevar University of Medical Sciences. Iranian Journal of Medical Education. 2013; 12(12):916–924 [Persian].
26. Nibbelink, C. W., Young, J. R., Carrington, J. M., & Brewer, B. B. Informatics solutions for application of decision-making skills. Critical Care Nursing Clinics. 2018; 30(2): 237–246.
27. Roh YS, Lee WS, Chung HS, Park YM. The effects of simulation-based resuscitation training on nurses' self-efficacy and satisfaction. Nurse Education Today. 2013;33(2):123–128.
28. Endacott R, Scholes J, Cooper S, McConnell-Henry T, Porter J, Missen K, Champion R. Identifying patient deterioration: using simulation and reflective interviewing to examine decision making skills in a rural hospital. International Journal of Nursing Studies. 2012;49(6): 710–717.
29. Boushehri E, Arabshahi KS, Monajemi A. Clinical reasoning assessment through medical expertise theories: past, present and future directions. Medical Journal of the Islamic Republic of Iran. 2015;29:222.
30. Okoli J, Watt J. Crisis decision-making: The overlap between intuitive and analytical strategies. Management Decision. 14 May 2018; 56(5):1122–34.
31. Jahanpour F, Sharif F, Salsali M, Kaveh MH, Williams LM. Clinical decision-making in senior nursing students in Iran. International Journal of Nursing Practice. 2010 Dec;16(6):595–602.
32. Şahin G, Başak T. The Effect of Virtual Patient Simulation on Nursing Students' Clinical Decision Making and Problem-Solving Skills. Journal of Education and Research in Nursing. 2021 Jun 1;18(2):118–23.
33. Parker CG. Decision-making models used by medical-surgical nurses to activate rapid response teams. MedSurg Nursing. 2014 May 1;23(3): 159–1.63.
34. Shariati M, Younesian M, Tahrirchi I, Khosravi A. The effect of virtual patients on surgery training in medical students: A Randomized controlled study. Journal of Knowledge and Wellness of Shahroud University of Medical Sciences 2008; 1(3): 2–8 [Persian].

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