
Virtual patient simulation: Promotion of clinical reasoning abilities of medical students

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Abstract:

Objectives: Virtual patient simulation (VPS) is used in the education of health care professionals. This method brings an opportunity for the learner to examine necessary diagnostic and therapeutic skills. The aim of this study was to assess the efficacy of VPS on clinical reasoning abilities of medical students and to evaluate their attitude towards VPS in clinical endocrinology course in a teacher centered educational environment.

Methods: Fifty-one medical students in their 6th academic year were simply randomized in two groups, the simulation and the control. The students in the simulation group were provided by an application which presented them virtual case scenarios on diagnosis and management of thyroid nodules and osteomalacia. All the students sat for a diagnostic test at the beginning and at the end of the course. The test comprised a series of essay questions matched for their academic level and closely related to the case scenarios. They were also asked to complete a questionnaire to assess their attitude towards the application.

Results: Participants in both groups did not have any statistical differences in scientific background in basic sciences ($P=0.672$) and prior clinical examinations ($P=0.376$). At completion of the course the mean score of the students in the simulation group improved significantly compared to the students in the control group by 3.5 vs. 1.0 points ($P=0.001$). The students found the application worthwhile and showed a positive attitude towards it.

Conclusions: Virtual patient simulation improved clinical reasoning abilities of medical students in the context of a traditional teaching/learning environment.

Keywords: Simulation; Clinical reasoning; Medical education

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1. Introduction

Active engagement of learners with various experiences is fundamental for effective learning to occur, and self-directed learning has been suggested as a favorable method that promotes lifelong learning in medicine (Murad & Varkey, 2008). In fact medical students need to elaborate sufficient skills to be lifelong learners in their future profession (Murad, Coto-Yglesias, Varkey, Prokop, & Murad, 2010).

In clinical decision-making, efficient problem-solving skill is needed during a brief period of time (Stary & Weichhart, 2012; Wu & Wang, 2012). The traditional bedside teaching and apprenticeship model of teaching and learning do not entirely cover all of the necessary skills that a medical student needs to accomplish.

Virtual patient simulation is increasingly used in the education of health care professionals. This method brings a special opportunity for the learner to develop and examine necessary diagnostic and therapeutic skills before encountering actual patients in the real world (Klein, 2000; Tang, Lan, & Chang, 2012). Virtual environment provides a situation for students to encounter patient management from the beginning to the end. In this way, the learner not only develops relevant basic practical skills but also becomes competent in complex cognitive abilities such as decision making and treatment planning (Janda et al., 2004).

In Iran, clinical teaching is based on traditional methods of teaching and learning and self-directed learning might not be promoted by the current teaching/learning methods.

The aim of this study was to evaluate whether virtual patient simulation application improves clinical reasoning skills of medical students during their clinical endocrinology course in a teacher centered educational environment based on a traditional curriculum.

2. Methods and materials

2.1. Participants

Fifty one medical students in their 6th academic year were enrolled in the study during their 4-week clinical endocrinology course. They were randomly assigned in two groups using simple allocation method. The simulation group was constituted of 29 students and the control group comprised of 23. Baseline characteristics of the participants are illustrated in table 1.

Table 1

Baseline characteristics of participants (14 students did not fill out the demographic characteristics' part of the questionnaire)

variable	Simulation Group		Control Group		p-value
	number	percent	number	percent	
Gender					
Female	21	72%	16	70%	0.822
Male	8	27%	7	30%	
Age (years)					
Mean (\pm SD)	25.63(\pm 1.13)		26.11(\pm 1.23)		0.213
Marital status					
Single	21	%60	15	83%	0.113
Married	8	%40	3	17%	
Accommodation status					
local	16	%80	12	67%	0.351
dormitory	4	%20	6	33%	

2.2. Study design

The academic syllabus, as well as the course program were provided and explained in detail to all students at the beginning of the course. All participants were enrolled in traditional educational programs including didactic lectures, case-based small group discussions, bed-side face to face teaching sessions, and interactive OPD teaching clinics. The simulation group was also provided with the application designed on nodular thyroid disease and osteomalacia, the two common subject matters in clinical endocrinology. Before the study, an introductory session was held for the simulation group in order to familiarize them to the various functions of the application.

All the students in both simulation and control groups were asked to sit for a diagnostic test at the beginning of the course (pre-test). The same test was taken at the end of the course (Post-test). The exams were constituted of two case scenarios on osteomalacia and thyroid nodules. Essay questions were developed by an expert in the field and were matched for the academic level of the students. They included 10 questions (five for each case scenario) on essential points in history and physical examination, indispensable paraclinical evaluations and their relevance to the clinical setting, and the most appropriate treatment plan. The exams were marked by an expert blinded to the study groups and the scores were compared between two groups.

Students in simulation group completed a 5-item questionnaire using likert scale to rate whether: 1) the application was effective regarding their learning skills, 2) they prefer to use such a tool in other clinical courses, and 3) they would recommend use of similar applications to their peers. They were also asked to state the total amount of time required to go through the applications and answer the questions.

2.3. Virtual case scenarios

To reflect a real scenario, the virtual case-scenarios were created from actual clinical setting. The application was divided into five sections: patient-interview, physical examination, paraclinical investigation, problem list/clinical impression, and treatment plan and feedback.

The students were asked to go through these steps in order to gather appropriate information and formulate the most likely diagnosis and select the most suitable treatment plan.

At the beginning, a brief description of the case scenario appeared on the screen. For instance: “A 65 year-old man who had referred due to anterior neck swelling since one month ago.” Then the student was free to go through the sections.

2.4. Patient-interview

The application began with an instruction for the student to choose relevant question(s) from a list of options. Some of the options played as distractors and did not necessarily provide relevant information. By choosing an option, the student could find the answer as a text. Then he/she was free to navigate other options or go to the next step.

2.5. Physical examination

In this section the student could select, from a list of physical-finding options, what he/she thought that might provide relevant information according to the scheme being constructed from the activities done in the previous section.

2.6. Paraclinical investigation

By choosing an image, a new window would open that illustrated the selected item. The image might be an ECG, X-ray, Scintigraph, or echocardiograph. By ordering a lab test the results would appear as texts. No interpretation was provided when an image appeared on the screen.

2.7. Problem list/Impression

When the student was convinced that all needed information had been gathered, he or she was asked to make a list of problems and decide about the most likely diagnosis, i.e., impression.

2.8. Treatment plan

It was proposed from the interactive activities in previous sections that the student could select the most appropriate treatment plan from a list of possible suggestions.

2.9. Feedback

All activities were saved and the application informed the student about what questions, examinations, lab tests, or requested images were unnecessary and which ones should have been selected as an obligation.

At the end, a brief description on the major aspects of the subjects matter would also have been provided as a text.

2.10. Statistical analysis

The collected data was analyzed using SPSS (Statistical Package for the Social Sciences) version 17 for Windows. The mean total scores were compared among different categories of respondents by using appropriate statistical tests. Unpaired student's T test was used for dichotomous variables. Independent sample T-test was used to compare means between case and control groups. Paired-samples T test was used to compare the mean scores of the participants. ANOVA was used to test means of time spent on virtual patient simulation module in post-test scores. A P-value of less than 0.05 was considered as statistically significant.

3. Results

Fifty one medical students, in their 6th academic year, participated in this study. The scores they had obtained during their previous academic years showed that their scientific background was similar. The average scores of the participants in the basic sciences exams was 128.2 (out of a possible maximum score of 150) in simulation group and 130.6 in the control group without any statistically significant differences (P = 0.672). The situation was the same for clinical examination scores: 123.3 vs. 123.8 (P = 0.376) (Table 2). At the end of the study, the average score of the simulation group and the control group in post-test exam showed a very statistically significant difference; the mean scores in simulation group increased by 3.5 points compared to only 1.0 point in the controls. Students' scores in the first and the second diagnostic exams and the effect size of the intervention are shown in Table 3.

Table 2
Students' scores in basic sciences and clinical examinations

Test	Simulation Group Mean(\pm SD)	Control Group Mean(\pm SD)	Mean Difference	p-value
Basic sciences exam	128.2 \pm 23.6	130.6 \pm 7.16	2.4	0.672
Clinical examination	123.3 \pm 17.45	123.8 \pm 18.22	0.5	0.376

Table 3
Students' scores* and the effect size of the intervention

Test	Simulation Group Mean(\pm SD)	Control Group Mean(\pm SD)	Mean Difference	CI	p-value
Pre-test (score)	7.103(\pm 2.12)	5.739(\pm 2.66)	1.36	0.02-2.69	0.045
Post-test (score)	10.55(\pm 2.81)	6.73(\pm 1.93)	3.82	2.43-5.19	0.000
Effect size	3.50(\pm 2.29)	1.08(\pm 2.67)	2.45	1.01-3.78	0.001

*The maximum obtainable score was 20.

Of 29 students in simulation group 45% believed that the application had a profound effect on their learning, 36% found it to have a moderate effect and 9% evaluated its effect as minimal.

The students reported a wide range of allocated time for the task that was from two hours per day in 36% to four hours per week in 27%, and two hours weekly in the remaining. No correlation was found between the amount of time spent for the application and the mean score obtained in the post tests. Fifty nine percent of the students in simulation group mentioned that they would like to use similar applications in their future clinical training courses and fifty nine percent stated that they would recommend use of similar applications to their peers.

4. Discussion

This study was the first to explore the effect of virtual patient simulation in a clinical course setting in Iran. The results showed a significant and meaningful improvement in clinical reasoning skills of medical students.

It has long been reported that simulation of actual patient might improve decision-making and clinical performance (Dugas, Batschkus, & Lyon, 1999; Hayes & Lehmann, 1996; Kushniruk, 2011). Newell and Simon (1972) put an emphasis on the limitations of human capacity for rational thought. Clinical decision-making is a complex process and needs different strategies to be adopted. It is unrealistic to assume that decision-making skills can be acquired without structured counselling (Newell & Simon, 1972).

Clinical reasoning involves the recognition of numerous stimuli and analysis of the facts in clinical setting (Hammond, 1964) Virtual patient simulation is a method that enhances clinical reasoning abilities (Botezatu, Hult, Tessma, & Fors, 2010). Moreover, such a tool provides a safe environment for the students to organize their knowledge and acquire decision-making ability. So, they become more confident when they encounter real patient in daily clinical practice (Janda et al., 2004).

Apart from the importance of manpower planning (Bond & Spillane, 2002), the value of good support staff cannot be underestimated in creating a realistic environment (Seropian, 2003). Meanwhile, VPS requires an expert leader in the field. A successful program requires teamwork to prepare the scenarios, to ensure integration into the existing curriculum, and to moderate the program in the context of the existing educational environment (MacGougan & Lam, 2005). Virtual patient simulation could be considered as a bridge to the real world of clinical care, not as a replacement for training on real patients.

The main characteristics of Virtual Patient application used in this study were freedom in flow, and providing immediate feedback at the end of the task, which engage the learners actively and hence reinforce their learning.

Nowadays, high quality and safe patient care is a major concern in hospital settings (Maslovitz, Barkai, Lessing, Ziv, & Many, 2007). An important feature of virtual patient simulation is that students practice in a safe environment without any fear to face with negative judgments, or put the patient in danger or harm (Grundman, Wigton, & Nickol, 2000; Schitteck, Mattheos, Lyon, & Attstrom, 2001).

Using the application, the students can move freely backwards and forwards, and re-evaluate the situation. In this way, they can acquire clinical-reasoning ability in a controlled environment.

Although VPS is increasingly used in clinical education, there are still major barriers to its use in health care education. Fidelity and validity issues are being considered as the major barriers to implement it in clinical setting (Day, 2006). Large collaborative centers are needed to overcome the cost and manpower issues (Bradley, 2006). Despite these problems, worldwide acceptance of this type of training is growing (Rosen, 2008).

The average time the students spent on the tasks in this study was short although they got a higher score in the post-test exam. This means that getting involved with the application resulted in a significant improvement in their clinical reasoning skills compared with the control group.

Another important finding of this study was positive attitude of the students towards the use of the application, and self-reported effectiveness of the tool on their learning.

A major strength of the study is its design as a randomized controlled trial to test the efficacy of virtual patient simulation on clinical reasoning skills of medical students compared to traditional teaching methods, but, the advantages of this strategy in all undergraduate clinical training programs, and its cost-benefit ratio remain to be clear. Meanwhile, providing the simulation group with the application might be claimed as bias; however, due to the study design it was inevitable.

5. Conclusion

In clinical settings, an effective virtual patient simulation provides the medical students with full understanding of clinical contexts, enabling them to consider medical history and physical examination, identify the most relevant paraclinical tests, and implement an optimal course of action. These diagnostic skills could be acquired through repeated interactions with “real case scenarios”. It provides an opportunity for students to practice a variety of case-based scenarios in a reproducible and objective learning environment prior to encounter a real world situation.

6. Limitation

Although this study showed a significant and meaningful improvement in clinical reasoning skills of medical students who used virtual patient simulation module, the most important limitation of our study was the small sample size.

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