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Virtual Integrated Patient: An AI supplementary tool for second-year medical students

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Abstract

Introduction: With the COVID-19 pandemic, Singapore underwent a national lockdown in which most organisations, including schools were closed. Halting face-to-face tutorials resulting in decreased clinical contact for medical students. Prior to the pandemic, we had developed the Virtual Integrated Patient (VIP). Equipped with conversational technology, it provides students online practice in various clinical skills such as history-taking, physical examination and investigations. The aim of this paper is to describe the supplementary use of VIP in the second-year class, in which a pilot study was conducted.

Methods: The VIP platform was introduced to the cohort and used to supplement the teaching of history-taking in the "Communication with Patients" (CWP) module for second-year students. Traditionally, CWP tutorials involve face-to-face history-taking from standardised patients (SPs). Students, who consented to participating in the trial, had an additional 3 weeks' access to VIP to practice their history-taking skills. They completed a survey on their user experience and satisfaction at the end of the 3 weeks.

Results: Out of the 106 participants, 87% strongly agreed or agreed that using VIP helped in remembering the content while 69% of them felt that VIP increased their confidence and competence in history-taking.

Conclusion: VIP was well-received by students and showed promise as a tool to supplement history-taking tutorials, prior to students' encounter with SPs and real patients. Hence, this trend showed its potential as an alternative when clinical rotations were delayed or cancelled. Further research can be done to evaluate its effectiveness in this context.

Keywords: *Medical Education Tool, Virtual Patients, Communication, Skill Acquisition, Chatbot, Conversational*

I. INTRODUCTION

Clinical skills that are commonly practised face-to-face were a challenge for students to practise during the onset of the Novel Coronavirus (COVID-19) in Singapore. Singapore underwent a 2-month lockdown during which time most non-essential organisations, including medical schools were closed nationwide. In our institution, lectures and tutorials were moved online and face-to-face clinical teaching on campus and in hospitals were cancelled. This move necessitated the use of virtual tools, such as remote meeting through Zoom and the use of virtual patient simulators that do not require the students to be physically on campus.

Virtual patient simulators have been used in a wide range of medical education settings, ranging from the teaching of clinical reasoning, procedural skills, communication skills, and integrated performance to critical thinking (Kononowicz et al., 2019). In recent years, there has been increasing use of virtual patients in the healthcare sector and technology improvements will continue to grow. The Virtual Integrated Patient (VIP) is a virtual patient

simulator that was created by our team prior to the pandemic. It leverages on artificial intelligence (AI) technology advancements in the area of naturalistic conversational technology. Prior to VIP, existing technology platforms were focused on the linear, semi-linear and menu-driven (with drop-down option boxes) simulators and there were very few developed in free-text conversations (Kononowicz et al., 2015). The VIP has a natural language processor that is flexible to adapt and adjust to conduct a realistic conversation that can enhance specific skill acquisition (Cendan & Lok, 2012; Kononowicz et al., 2019).

The next unique feature of the VIP is the random patient generator (Figure 1a and b). Every time a student logs in, a new patient is generated. They can revisit the past patients if they have not completed the case and restart where they have left off. The random patient generator provides a realistic situation for users that no two doctors will see the same patient at the same time increasing in variability of patients and potentially, diagnoses. Users can also probe into their virtual patients' history in their unique ways. Integration of natural language processing using conversational technology has allowed users to chat with the virtual patient as though they are chatting with a real person (Figure 1c). The virtual patient is trained with data sets and is AI-learning enabled. Wi-fi connectivity allows VIP to be accessed anywhere and at any time. It is a safe environment where students are able to make mistakes without any penalty and learn from it. VIP has interfaces for history-taking through a chatbot, physical examination, and laboratory investigations as seen in Figure 1c to d.

The aim of this short communication is to describe how VIP has been employed in a history-taking module for second-year medical students. VIP may play a role in providing a platform for users to consistently practise their skills during a global pandemic where face-to-face tutorials are limited.

Figure 1. a to d. Screenshots of the Virtual Integrated Patient (VIP) interface; b. An example of a random patient generator with no same patient; c. In the history-taking screen, the user can chat with a randomly generated virtual patient, who generates answers using the pre-loaded content and the natural language processor; d. Left: The physical examination screen. d. Right: The laboratory investigations screen which provides realistic case information given explicit buttons throughout interface for easy navigation. Bottom Panel: e to f: Skill Retention Confidence survey results.

II. METHODS

This study's information sheet, study plan, instruction slides, and survey forms were submitted to the National University of Singapore's (NUS) institutional review board (IRB) for assessment. It was approved with the study approval code of S-19-263.

VIP was introduced to Phase II "Communications with Patients" (CWP) module in Academic Year (AY) 2019/2020. In this module, students usually clerk a total of three to six standardised patients (SPs) for three sessions over a course of 3 weeks. VIP was introduced to supplement the CWP curriculum. On top of clerking three to six SPs in 3 weeks, participants were given access to VIP during the same 3 weeks. VIP was loaded with cases that complemented and reinforced the

contents taught during tutorials, with the aim to deepen students' understanding of the tutorial content and train them to use the history-taking framework taught during the module.

The VIP team introduced the VIP computer programme and how to use it during the first lecture of the CWP module. Recruitment was done and informed consent was taken from the willing participants for the study. All Phase II students enrolled in the course (n=296) were divided into two groups: the first group received access at the first tutorial (intervention group) and the other group with no access (control group). Eventually, all students from both groups (intervention and control) had received access to the VIP by the end of first week and they could practise over the remaining 2 weeks of the study. Participants were asked to complete a survey at the end of 3 weeks. This is to provide an insight on their confidence levels in executing the history taking exercise and key takeaways with VIP usage at the end of the study.

Students who declined to participate in the study would still have received access to the VIP, but only after the study period of 3 weeks. This ensured fairness for all second-year medical students to have 6 months to practice on the VIP system before their OSCE (Objective Structured Clinical Examination) at the end of the semester.

Following the 3 weeks of tutorials, students were encouraged to continue practising using the VIP prior to the OSCE which was scheduled to be at the end of the academic year. The original study protocol included collection of participants' history-taking scores at the OSCE, but this was not possible as the OSCE was cancelled due to the COVID-19 situation in Singapore.

III. RESULTS

We obtained quantitative survey responses (n=106 respondents out of 298; 35% response rate). They indicated positively to VIP with 87% of students feeling that using VIP helped in remembering the content. And 69% of the students strongly agreeing or agreed that VIP increased their confidence in taking history (Figure 1f and g).

Students also provided qualitative responses of the key takeaways with the supplementary usage of VIP with their curriculum. First, they indicated that they were able to execute the history-taking procedures more efficiently with additional practice on the VIP. Second, students indicated that they could better remember the methodological content taught in class after repeated usage, thus reinforcing the procedural history-taking skills. Last but not least, survey respondents also reported enhanced understanding of the multiple facets of presenting cases. Where they learnt more about each diagnosis from the summary page after each case completion.

IV. DISCUSSION

VIP was well-received by students in CWP. Users' survey responses reiterated that more practice aided their skill acquisition, helping them to score in their examinations. By keeping the simulation realistic, they could transfer the skills back into their clinical attachments in future. Also, adding VIP supplementary to the planned curriculum, students were provided additional practice that past years students have requested for in course feedback.

Traditionally, CWP students could only clerk three to six SPs during the whole course of module over a span of 3 weeks. Thereafter, they would not have any chance to practice their history-taking skills through the clerking of SPs until their OSCE which would happen half a year later. Over the years, students provided feedback that they did not receive adequate practice prior to the OSCE and practising on their friends was not feasible due to the hectic nature of their curricular commitments. However, this barrier could not be overcome due to the constraints of the packed timetable of the Phase II students. Therefore, current phase II students who reported that VIP enhances their efficiency and has provided them with adequate practice suggest that VIP is a promising supplement for the course.

One key objective of the VIP is to focus on the processes of getting to a diagnosis rather than just the right diagnosis itself. Medical students' focus usually stems from the diagnoses to symptom as they are taught in that framework. The enhanced understanding of case definition through the case summaries were welcomed due to the realistic nature of their experiences and how it can be related in the actual clinics. This therefore enhances the students' enthusiasm toward the usage of the platform. Furthermore, the intention of this was to ease the performance anxiety faced by the students by preparing them in a low-stakes environment, helping them to boost their confidence, in facing SPs or real patients. The study results resonated with this purpose as the students reported greater confidence and efficiency in taking family history after using VIP.

Moreover, the availability of VIP appealed to the students. Due to their curricular commitments, students are more often than not, on the go. While travelling or waiting for a class, where there is available Wi-Fi

connectivity, they can log on and practise clerking patients on the simulator. Some students who were not able to attend tutorials were slightly disadvantaged as they would lose one or two SP clerking from the 3 weeks.

V. CONCLUSION

With greater confidence and better utilisation of CWP framework among the students who utilised VIP, VIP is promising as a tool to supplement face-to-face history-taking tutorials. It may have potential use in a pandemic situation where medical students have reduced access to in-person clinical teaching. However, further research is needed to establish its effectiveness as an alternative to in-person clinical teaching.

Notes on Contributors

Author 1, Juanita Kong, was involved in the data collection, analysis, writing, reading, and the final submission of this manuscript. Author 2, Teo Boon See was involved in the planning and execution of this study, writing, reading, and the submission of this manuscript. Both Authors 1 and 2 have equal contribution to the manuscript. Author 3, Lee Yueh Jia, was involved in the data collection, analysis and the reading of this manuscript. Author 4, Anu Bharath Pabba, was involved in the data collection and programming of the tool. Author 5, Edmund Lee was involved in the conceptualisation of the study, data collection, analysis, reading and the final approval of this manuscript. Author 6, Judy Sng, was involved in the conceptualisation of the study, data collection, analysis, reading and the final approval of this manuscript.

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Declaration of Interest

There are no conflicts of interests in this study.

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