

PATient Safety in Surgical EDucation (PASSED): A Pilot Study Using iPad Game to Teach Patient Safety in Undergraduate Medical Curriculum

Dear Editor,

In 1991, after the Harvard Medical Practice Study reported on the adverse events and negligence in hospitalised patients, there was a major tsunami in the healthcare systems around the world to improve patient safety in the hospitals.¹ While healthcare outcomes have improved significantly over the past 3 decades, the complexity of medical technology and service demands has also escalated the risks in patient safety. Therefore, patient safety education is extremely crucial in cultivating the practice of safe medicine. Recognising that the newer generation medical students have very different learning habits as a result of rapid development of computers and easy access to the Internet, harnessing the unique features of mobile devices such as an iPad can help to bridge the gap in the learning habits of these students. Serious games in healthcare is increasingly gaining popularity as it allows repeatable safe training before the learners move on to work as healthcare professionals in the real world.

Materials and Methods

The Undergraduate Education Team from the Department of Surgery, Yong Loo Lin School of Medicine at the National University of Singapore created an iPad game called PASSED, which stood for “PATient Safety in Surgical Education”. It was a 10-scenario interactive game which was developed using cases from the archive of sentinel events and serious reportable events in the hospital. The scenarios explored the concepts of patient safety in 3 main areas (Table 1): Group A – Interpretation of critical investigation results; Group B – Identifying correct tools and equipment in administering critical medications; and Group C – Prioritisation of multiple tasks or communications with healthcare workers in critical situations.

We conducted the pilot study in June 2014 with a group of Phase III medical students (n = 53), who were doing surgery rotation. The session started with a presentation on the principles of patient safety using the World Health Organization (WHO) Patient Safety Curriculum Guide for Medical Schools.² The game started with a page showing brief instructions on how to play the game. The students played the role of a surgical resident and interacted with the nurses in the surgical ward during a night call. As the

Table 1. Grouping of Scenarios According to the Area of Interest

| Group A | | |
|---|---------------------|---|
| Interpretation of critical x-ray/ laboratory results | Scenario 1 | Pneumoperitoneum representing perforated viscus. |
| | Scenario 4 | NG tube in right bronchus on x-ray. |
| | Scenario 6 | ECG showing hyperkalaemic changes. |
| Group B | | |
| Identifying correct tools/instruments and correct administration of medications | Scenario 2 | NG tube testing with litmus paper vs CXR. |
| | Scenarios 5A and 5B | Hypotension needing fluid resuscitation – choosing correct drip, appropriate rate to run the fluid. |
| | Scenarios 9A to 9E | Correcting hyperkalaemia using correct vial of actrapid, correct insulin syringe, drawing correct volume, giving it according to correct method and lastly, on the correct site of the peripheral IV cannula. |
| Group C | | |
| Learning prioritisation of tasks/appropriate communication methods in critical situations | Scenario 3 | Patient with seizure vs reviewing at repeat CXR. |
| | Scenario 5C | Appropriate reaction to trigger call from nursing staff. |
| | Scenario 7 | Prioritisation of 3 tasks at the same time. |
| | Scenario 8 | Appropriate response to call centre informing critical laboratory results. |
| | Scenario 10 | Appropriate response to critical radiological report trigger on workphone. |

CXR: Chest x-ray; ECG: Electrocardiogram; IV: Intravenous; NG: Nasogastric

story progressed, there were intermittent interjections of critical lab results or calls from nurses to inform on ill patients (Fig. 1). The intention was to simulate busy night calls where prioritisation of critical tasks was required. We added interesting features such as extra bonus marks

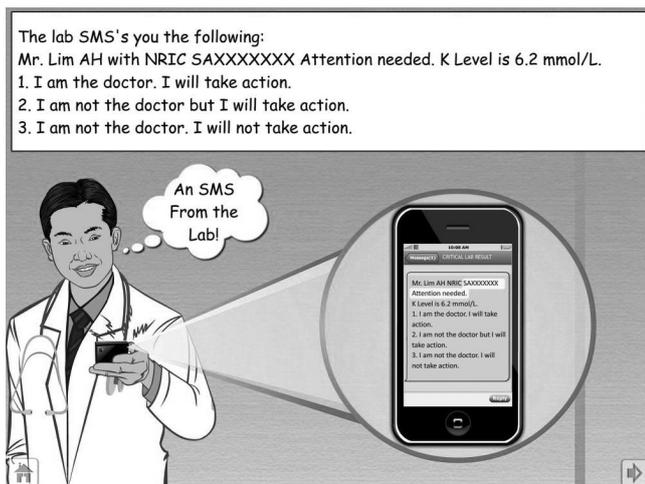


Fig. 1. One of the scenarios where students were required to prioritise the tasks that were linked to patient safety.

for correct answers given within 10 seconds. Each step allowed a maximum of 2 attempts. Each wrong attempt entailed demerit points. Each student could view their performance in each of the scenario in detail at the end of the game. Perception of students' patient safety awareness was conducted using the Attitude to Patient Safety Questionnaire-III (APSQ-III) before and after the game.³

Results

Table 2 shows the overall performance score of the students in this cohort.

Group A – Interpretation of Critical X-rays or Lab/Investigation Results (Table 3)

In Scenario 1, more than half (41.5%) of the students missed the pneumoperitoneum (after 2 attempts). A Ryles tube was misplaced into the right bronchus as noted on the chest x-ray (CXR) in Scenario 4 and 81.1% of students spotted the problem and chose to pull the tube out entirely and reinsert. In Scenario 6, a similar proportion of students (84.9%) was able to identify the hyperkalaemic changes on electrocardiogram at the first instance.

Group B – Identifying the Correct Tools/Instruments and Correct Administration of Medication (Table 3)

In Scenario 2, students were asked about the most reliable method to check the position of the Ryles tube and 51.0% answered correctly. Majority of students answered correctly in Scenarios 5A (92.6%) and 5B (96.3%). In Scenario 9, where intravenous insulin was used to correct hyperkalaemia, 11.3% failed to choose the correct type insulin on their first attempt (9A), 37.8% chose the wrong

Table 2. Overall Performance Score of Students on PASSED iPad Game in this Pilot Cohort

| | Median | Range | Mean | SD |
|--------------------------|--------|---------|-------|------|
| Overall posting 1 scores | 27 | 9 to 41 | 27.11 | 7.28 |
| Group A Score | 5 | -1 to 7 | 4.57 | 1.64 |
| Scenario 1 | 1 | 0 to 3 | 0.89 | 0.95 |
| Scenario 4 | 1 | -3 to 2 | 1.55 | 1.03 |
| Scenario 6 | 1 | -1 to 7 | 1.83 | 0.43 |
| Group B | 16 | 3 to 29 | 15.26 | 6.63 |
| Scenario 2 | 2 | -1 to 3 | 1.68 | 1.45 |
| Scenarios 5A and 5B | 7 | -4 to 9 | 5.92 | 3.03 |
| Scenarios 9A to 9E | 16 | 3 to 29 | 15.34 | 6.69 |
| Group C | 17 | 5 to 19 | 15.06 | 3.52 |
| Scenario 3 | 3 | -1 to 3 | 2.38 | 1.27 |
| Scenario 5C | 7 | -4 to 9 | 5.92 | 3.03 |
| Scenario 7 | 2 | 0 to 2 | 1.83 | 0.47 |
| Scenario 8 | 2 | 0 to 2 | 1.92 | 0.39 |
| Scenario 10 | 3 | 3 to 3 | 3.00 | 0.00 |

SD: Standard deviation

syringe to draw the Actrapid insulin (9B), 32.1% chose the wrong volume of Actrapid insulin on their first attempt (9C), 51.9% administered wrongly on their first attempt (9D) and 24.5% chose the arm with arteriovenous fistula in an end-stage renal failure patient to administer the medications (9E).

Group C – Learning Prioritisation of Tasks/Appropriate Communication in Critical Situations (Table 3)

In Scenario 3, 88.7% of the students responded correctly to prioritise treating a patient who had suddenly developed seizures over reviewing a repeat CXR following Ryles tube insertion. In the rest of the scenarios, more than 90% of students responded correctly – Scenario 5C (98.1%), Scenario 7 (86.8%), Scenario 8 (96.2%) and Scenario 10 (100%).

The students felt that the various aspects of patient safety awareness according to the APSQ-III was significantly better after the game (Fig. 2).

Discussion

Using computer or video games for training in military, education, manufacturing, health and medicine is defined as serious games.⁴ Considering the learning habits of the current generation of students, serious games can help to increase interest in training and education. In addition, evaluation of user performance can be easily conducted.^{5,6} This PASSED game aims to impart knowledge and raise awareness for patient safety in medical students. Different

Table 3. Responses of Students on the Scenarios in the PASSED Game

| Scenario | Results | % |
|---|---|------|
| Group A: Interpretation of critical x-rays or lab/investigation results) | | |
| Scenario 1 – Pneumoperitoneum on CXR | Wrong after 2 attempts | 41.5 |
| | Correct at second attempt | 37.7 |
| | Correct at first attempt | 11.3 |
| | Bonus correct 10 seconds* | 9.4 |
| Scenario 4 – NG tube in right bronchus | Wrong after 2 attempts | 1.9 |
| | Correct at second attempt | 17.0 |
| | Correct at first attempt | 81.1 |
| Scenario 6 – ECG showing hyperkalaemic changes | Wrong after 2 attempts | 3.8 |
| | Correct at second attempt | 5.7 |
| | Correct at first attempt | 90.6 |
| Group B: Identifying correct tools/instruments and correct administration of medications | | |
| Scenario 2 – NG tube placement (testing with litmus paper vs CXR) | Wrong after 2 attempts | 15.1 |
| | Correct at second attempt | 33.9 |
| | Correct at first attempt | 3.8 |
| | Bonus correct 10 seconds* | 47.2 |
| Scenario 4 – NG tube in right bronchus | Wrong after 2 attempts | 1.9 |
| | Correct at second attempt | 17.0 |
| | Correct at first attempt | 81.1 |
| Scenario 5A – Hypotension resuscitation (drip type) | Correct drip chosen at first attempt | 39.6 |
| | Correct drip chosen at second attempt | 52.8 |
| | Wrong drip after 2 attempts | 7.6 |
| Scenario 5B – Volume and rate of drip | Correct volume and rate at first attempt | 90.6 |
| | Correct volume and rate at second attempt | 5.7 |
| | Wrong volume and rate after 2 attempts | 3.8 |
| Scenario 9 – Correcting hyperkalaemia using insulin | | |
| Scenario 9A – Choice of correct type of insulin | Chose correct insulin at first attempt | 88.7 |
| | Chose correct insulin at second attempt | 3.8 |
| | Wrong insulin chosen after 2 attempts | 7.5 |
| Scenario 9B – Choice of correct syringe | Chose correct insulin syringe at first attempt | 62.3 |
| | Chose correct insulin syringe at second attempt | 34.0 |
| | Wrong insulin syringe chosen after 2 attempts | 3.8 |
| Scenario 9C – Choice of correct insulin volume | Chose correct insulin volume at first attempt | 67.9 |
| | Chose correct insulin volume at second attempt | 18.9 |
| | Wrong insulin volume chosen after 2 attempts | 13.2 |
| Scenario 9D – Choice of correct method of administration | Correct method to administer IV insulin at first attempt | 49.1 |
| | Correct method to administer IV insulin at second attempt | 47.2 |
| | Wrong method after 2 attempts | 3.8 |
| Scenario 9E – Choice of correct site to administer | Correct arm to administer (non-AVF arm) | 75.5 |
| | Wrong arm to administer (arm with AVF) | 24.5 |
| Group C (Learning prioritisation of tests/appropriate communication methods in critical situations) | | |
| Scenario 3 – Attending to seizure vs reviewing repeat CXR first | Chose to refer neuro first (10 seconds) | 71.7 |
| | Chose to refer neuro first | 17.0 |
| | Chose to look at CXR first (wrong) | 11.3 |

AVF: Arteriovenous fistula; CXR: Chest x-ray; ECG: Electrocardiogram; IV: Intravenous; NG: Nasogastric; SMS: Short message service

*Students were awarded additional points if they answered correctly within the first 10 seconds of the scenario.

Table 3. Responses of Students on the Scenarios in the PASSED Game (Con't)

| Scenario | Results | % |
|--|--|-------|
| Group A (Interpretation of critical x-rays or lab/investigation results) | | |
| Scenario 5C – Appropriate reaction to trigger call from nursing staff | Correct trigger response to nurse call (within 10 seconds) | 73.6 |
| | Correct trigger response at first attempt | 22.6 |
| | Correct trigger response after second attempt | 1.9 |
| | Wrong after 2 attempts | 1.9 |
| Scenario 7 – Prioritisation of 4 tasks at the same time | Correct rate at first attempt | 86.8 |
| | Correct rate at second attempt | 9.4 |
| | Wrong rate after 2 attempts | 3.8 |
| Scenario 8 – Appropriate response to call centre informing of critical lab results | Read back and thanked the operator (correct) | 96.2 |
| | Said yes but ignored the results (wrong) | 3.8 |
| | Unhappy at being called by the call centre (wrong) | 0.0 |
| Scenario 10 – Appropriate response to critical radiology report sent by SMS | Noted the report and went to review patient and case sheet | 100.0 |
| | Ignored the report | 0.0 |

AVF: Arteriovenous fistula; CXR: Chest x-ray; ECG: Electrocardiogram; IV: Intravenous; NG: Nasogastric; SMS: Short message service

from the usual simulation training, where large simulation machines or mannequins connected to computer systems are required, PASSED game only requires the students to bring mobile devices such as an iPad, and the gaming session can be conducted anywhere as long as there is wireless Internet connection. The portability and convenience is certainly a great advantage as compared to conventional simulation that requires large space facilities to house the simulation systems and machines.

Many studies have clearly shown that adverse events occur not because of negligent healthcare professionals intentionally harming patients, but rather the system of healthcare is so complex that the successful treatment and outcome for each patient is not dependent on the competence of an individual healthcare provider alone.² Using this gaming system, students can learn about patient safety in a safe environment. Another added advantage of this system is the repeatability of the games. In Group A, students were assessed on their ability to detect critical abnormalities on radiographs and laboratory investigations that could lead to severe morbidity and mortality. Under the gaming setting, students were allowed to revisit this scenario to enhance their memory and experience. At the same time, the experience of the whole cohort was uniform. Indeed, we have shown that students who learnt the concepts of patient safety repeatedly under a safe environment had better awareness in this area.^{7,8}

Human factor is a well recognised entity in patient safety studies. It studies the interrelationship between humans, the tools and equipment they use in the workplace, and the environment in which they work.⁹ Majority of the

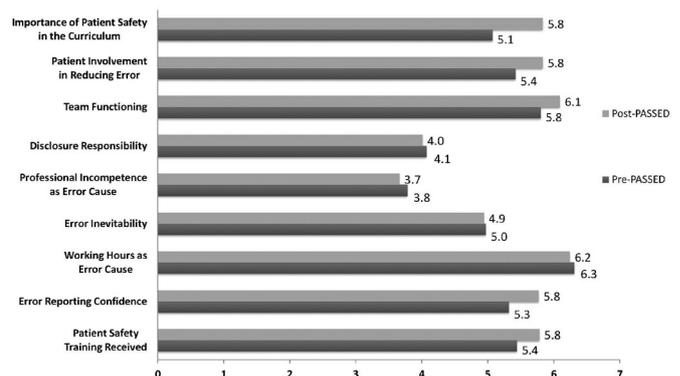


Fig. 2. Perception of patient safety before and after the PASSED test using APSQ-III questionnaire.

students did well in the interpersonal communication skills under critical situations. This reflected the earlier training that the students received in the preclinical years where the concept of “situation-background-assessment-recommendation” helped to enhance their understanding on the importance of effective communications between other healthcare workers. When a healthcare professional has to handle multiple tasks simultaneously, the distractibility of human beings comes into play. Our ability to be distracted predisposes us to commit error and this could be harmful to patient care.¹⁰ Scenario 7 tested on this aspect and the students responded well. However, in real-life situations, the challenges could be more daunting. Therefore, in healthcare, human factors knowledge can help to design processes that make it easier for doctors and nurses to do their job

right. Currently, abnormal investigation results are sent as a trigger to the on-duty doctors in the form of short-text messages, similar to that in Scenarios 8 and 10. To enhance patient safety in the healthcare practice, a system must be built to endure that critical investigation results are sent to the doctors and nurses immediately with reminders that are automatically sent unless actions are taken to reduce the patient safety errors in hospitals.¹⁰

In this era, undergraduate medical curriculum must be focused, yet robust. While the core knowledge of medicine can be taught using conventional methods, certain areas such as patient safety concepts could be delivered in a more interesting way. We believe that using iPad gaming system to teach patient safety is effective as it provides additional avenue to allow uniform exposure outside of conventional textbook teaching.

Conclusion

By using PASSED to enhance patient safety teaching, we found that medical students were good at basic communications with other healthcare workers and prioritisation of multiple tasks. Likewise, they performed well in interpreting critical investigation results. However, students did not do well when specific practical knowledge on instruments and administration of medications were evaluated. This unique teaching pedagogy using interactive gaming system can help identify gaps in patient safety training and raise awareness amongst future doctors in order to improve the healthcare system. Future research ideas for patient safety education could include games that train students on surgical competencies, time-out concepts, hospital infection control and the use of 2 patient identifiers to avoid misidentification. More interactivity could be created in future games as well.

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