Gaming to Enhance Students’ Patient-Safety Skills: Evaluation of Air Medic Sky One

Jorike Huiskes, Teus Weijs, Cor Kalkman and Olle ten Cate

Abstract

Aim: To evaluate the effects of a patient safety game, aimed to reduce preventable adverse events in health care through educational game-playing, on satisfaction, knowledge and self-efficacy.

Methods: Our institute developed a patient safety serious game called Air Medic Sky One (AMS-1), including expeditions, short lectures and biofeedback modules with a device that enables students to control the game with breath, heart rate and skin conduction, using stress reduction exercises. Final year medical students were asked to participate. Before and after playing AMS-1, participants completed a knowledge test on patient safety topics; self-efficacy was measured with a 100 mm visual analogue scale. A post-intervention evaluation questionnaire measured satisfaction with the game. Outcomes of both knowledge tests and self efficacy questions were compared using the Student’s t-tests.

Results: All 27 participants agreed that AMS-1 provides an entertaining and instructive experience; most found it time consuming (4 to 6 hours). Knowledge of patient safety issues increased significantly after playing the game. Self-efficacy measures showed a mean increase of 28.6% across different aspects of patient safety.

Conclusions: AMS-1 appears to be an instructive tool that deserves further, controlled investigation in its effect on actual patient safety behavior in the clinical environment.

Keywords: Patient Safety; Serious Gaming; Medical Students

Introduction

Patient safety has received much attention following the publication of ‘To Err is Human: Building a Safer Health System’ in 1999. This document showed that death rates attributable to preventable medical errors in the United States exceed the number of deaths due to motor vehicle accidents, breast cancer, or AIDS. Since that moment, several other studies documented the extent of medical errors and underlined the need for patient safety education. The Patient Safety Curriculum Guide for medical schools, recently published by the WHO’s World Alliance for Patient Safety, is a valuable aid in achieving this goal. This guide helps translating patient safety topics into curricular models. It identifies topics that a medical curriculum should contain and provides an overview of patient safety competencies to aim at. WHO recommends to improve the knowledge of techniques to increase patient safety, to promote alertness in identifying safety risks and to teach...
how to stay calm during critical, life-threatening situations. Studies about patient safety education for medical students include investigations of the effectiveness of lectures, workshops, discussion groups, video and audio case studies, written assignments and taped simulations.(4–10) All reports claim to be effective, but there is little consensus on the best teaching approach and the strength of the underlying evidence is limited. For example, Moskowitz et al used plenary sessions and workshops in a one-day program to inform medical students about medical errors and patient safety. Although attitudes and beliefs were improved, it required participants to attend in person and it took up an entire day.(8)

We wondered if there could be a more effective method to transfer information allowing for self-directed learning in a cost effective, generalizable way. An approach that contains active participation of students is likely to be most successful. Serious educational games (SEGs)—games with educational purposes beyond entertainment—might embody these elements. They have been shown to engage the learner through exploration and experimentation.(11,12) Learning is stimulated through increased visualization, creativity and interactive engagement. Serious gaming may be at least as suitable for patient safety training as any traditional mode of transferring medical knowledge. (13,14)

At University Medical Center Utrecht’s Patient Safety Center, an international team was established to develop a SEG for teaching and training in patient safety issues. This resulted in Air Medic Sky One (AMS-1), a SEG in patient safety, specifically designed for final year medical students and junior residents, completed in 2011.

This study is a first evaluation of the effectiveness of AMS-1 among senior medical students. We hypothesize that AMS-1 will increase learning satisfaction, knowledge, skills and personal confidence regarding patient safety issues in clinical practice.

Methods

Participants

Medical students entering the final year of the six-year medical curriculum at University Medical Center Utrecht (UMCU) were invited to participate in our study between November 2011 and May 2012. They were informed about the project by email and in face-to-face classroom meetings. Approximately 200 students were informed and given opportunity to participate.

The game: Air Medic Sky One

AMS-1 is an interactive biofeedback game, designed to teach residents ground rules of patient safety, teamwork and personal stress management (www.airmedicsky1.org). The game is set on a virtual flying hospital (AMS-1). The player enters this virtual world as a junior doctor. Goal is to be sent on a medical mission to a large-scale disaster area. Before being allowed to go on such a mission, players must get prepared in a simulated training centre. Here they are taught basic concepts of safe communication and teamwork through recorded lectures given by an international team of patient safety experts. Personal stress management is practiced during relaxation exercises using a device that enables students to control the game with breath, heart rate and skin conduction. Players earn credits after following lectures and completing exercises. When they have enough credits, they are invited to embark on medical missions with AMS-1. On board of AMS1 they face complex real-life like situations in which they must manage and treat patients. For example, they must treat patients caught by a forest fire. On these missions additional credits can be earned. After collecting sufficient credits on these three different aspects (lectures, relaxation exercises, and missions), the game is considered to be completed. Users typically take 3 to 6 hours to complete the game.

Outcome measures

This study aimed to demonstrate the effectiveness of AMS-1 at multiple levels of evaluation, in accordance with a modified version of Kirkpatrick’s hierarchy.(15) The first level of this hierarchy (Satisfaction) was measured by evaluating the game procedurally, using the participant satisfaction scores. Next, the participants’ self-efficacy related to twelve skills and the learning effect were both assessed in a pre-post test
model (Kirkpatrick level 2, Learning, i.e. knowledge and skill). Self-efficacy is defined as a person’s judgment of their capability to successfully perform a specific task. Behavior change (Kirkpatrick level 3) and Results, i.e. impact on the clinical environment (Kirkpatrick level 4), were not measured in this study.

The instrument used to measure satisfaction about the game was a written evaluation form. It contained 24 items that were scored on a 5-point Likert scale, (1=’strongly disagree’, (5=’strongly agree’). Participants were asked to rate the game as a whole on a scale from 1 to 10 (1=’most negative’, 10= ‘most positive). At the end, there was space to provide additional comments. To assess self-efficacy regarding patient safety, a 12-item questionnaire was designed, using 100 mm visual analogue scales, administered electronically. Students could rate their self-confidence related to specific patient safety behaviour, by moving a bar on a scale from 0-100 in an internet application (0= I cannot do this, 100= I can do this perfectly), a procedure validated by Turner et al.(16) To test the learning effect, a written test consisting of 126 multiple choice questions was designed. The test contained 100 true/false questions, 11 three-options multiple choice questions, 10 four-options multiple choice questions, 3 five-options multiple choice questions and 2 matching questions. The content validity was established through the construction of the test. All essential patient safety aspects of the game were covered with test items. The same test was administered before and after the game was played. Participants did not receive information about their score or which questions they had answered incorrectly.

Procedure
Each participant was asked to complete the knowledge test and the questions about self efficacy regarding patient safety, before playing the game. The game could be played either on a computer in the medical library of UMC Utrecht or at home. The expected duration of the game as announced was about 4 to 5 hours. Participants were permitted to interrupt the game if desired. The game was played from a USB device that was to be handed in afterwards. All pre and post tests were administered at UMC Utrecht. All tests and questionnaires were taken under supervision of a researcher (JH). There was no time limit to completing questionnaires or tests.

Data analysis
All statistical analyses were carried out using SPSS version 19. The knowledge test and self-efficacy scores were compared using Student’s T-tests. Cronbach’s alpha for internal consistency was determined to estimate the reliability of the knowledge test.

Ethical approval
Approval for this study was obtained from the Ethical Review Board of the Netherlands Association for Medical Education.

Results

Participants
In total, 30 students volunteered for this study. Two were excluded, because they did not complete the game. One student who did not complete the knowledge post-test was also excluded. This report is based on data of 27 participants. Table 1 provides baseline characteristics of the participants.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Participant characteristics</th>
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<tr>
<td></td>
<td>Total</td>
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<tr>
<td>Number (%)</td>
<td>27 (100)</td>
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<tr>
<td>Mean age (SD)</td>
<td>25.1 (3.9)</td>
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<tr>
<td>Mean days between pre- and post test (SD)</td>
<td>30.0 (29.7)</td>
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Satisfaction
All respondents (100%) agreed or strongly agreed that AMS-1 is a “fun” learning module to run and agreed that completing AMS-1 is instructive (mean score 4.26; SD 0.53). In particular, the missions within the game were rated very highly: they were found to be “fun to play” (mean score 4.93; SD 0.27), instructive (mean score 4.56; SD 0.58) and the level of the cases was judged to match their current level of knowledge (mean score 4.44; SD 0.58). The duration was considered to be rather long. Only 11.1% of the participants agreed or strongly agreed that the time needed to complete AMS-1 was “not too long” (mean score 2.61; SD 0.81), only 22.2% (strongly) agreed that they kept motivated to watch the presentations (means score 2.93; SD 0.73) and only 29.6% (strongly) agreed to stay motivated to complete all biofeedback exercises (mean score: 2.72; SD.1.30). The game received an overall mean rating of 7.50 on a 1-10 scale. Positive additional comments included: ‘missions are fun and exciting to play’, ‘the cases seem very realistic’, ‘much variation within the cases’. Recommended improvements included: ‘the time it takes to complete the biofeedback exercises is too long’, ‘please provide an overview of presentations which have been viewed already’ and some technical aspects like ‘let the game save itself automatically’ and ‘give a signal when the game is finished’.

Self-efficacy
Of the 12 self-efficacy ratings, 9 showed a significant pre-post increase (P<0.05). Across all twelve (Table 2, Figure 1), a mean increase was found of 14.5 mm on a 100 mm visual analogue scale, i.e. from 49.5 mm (SD 9.1) to 64.0 mm (SD 7.7) (P<0.001), implying a large effect size according to Cohen.(17)

Table 2: Increase on self-efficacy scores in experimental versus control group

<table>
<thead>
<tr>
<th>“Please indicate how you assess your ability to ...”</th>
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<tr>
<td>1 Physically reduce high levels of stress in yourself</td>
<td>***</td>
</tr>
<tr>
<td>2 Focus on one important task when dealing with multiple things at a time</td>
<td>***</td>
</tr>
<tr>
<td>3 Perform a debriefing within a team, e.g. before an operation</td>
<td>***</td>
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<tr>
<td>4 Hand over patient information</td>
<td></td>
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<tr>
<td>5 Recognize signals of threats to patient safety during teamwork</td>
<td>***</td>
</tr>
<tr>
<td>6 Conduct a debriefing after a team task</td>
<td>*</td>
</tr>
<tr>
<td>7 Raise issues of threat to safety of a patient among the medical staff</td>
<td>***</td>
</tr>
<tr>
<td>8 Recognize signs of depression in yourself</td>
<td></td>
</tr>
<tr>
<td>9 Recognize signs of depression in colleagues</td>
<td>**</td>
</tr>
<tr>
<td>10 Recognize signs of sleep deprivation in yourself</td>
<td></td>
</tr>
<tr>
<td>11 Recognize signs of sleep deprivation in colleagues</td>
<td>***</td>
</tr>
<tr>
<td>12 Approach a senior staff member personally for his or her negligence</td>
<td>***</td>
</tr>
</tbody>
</table>

1 Pre-post increase difference between experimental and control group: *<0.05; **<0.01; ***<0.001
Figure 1  Mean post-test minus pre-test scores on twelve 100 mm VAS self-efficacy measures (N=27; for legend see Table 2)

Learning

The internal consistency of the knowledge test was satisfactory in both pre and post test (Cronbach’s alpha 0.63 and 0.87 respectively). The mean pre-test score was 72.9 points (SD 7.7) out of a maximum score of 126 points and 91.6 points (SD 11.4) for the post-test which is a significant increase (25.7%, P<0.001).

Discussion

Our study of a serious game, among 27 medical students, yielded encouraging results. Students found, as we hypothesized, AMS-1 to be entertaining and instructive. The level of complexity of the patient cases appeared to suit the level of knowledge of these final year medical students. The missions were rated highly, while the presentations and biofeedback exercises were generally considered somewhat long to sustain motivation to play the game. Self-efficacy scores regarding patient safety tasks or skills increased after playing AMS-1. Particularly “physically reducing stress levels in yourself” and “recognizing signals of threats to patient safety in teamwork”, “raising issues of threat to safety of a patient among the medical staff” and “focusing on one important task when dealing with multiple things at a time” showed a clear increase of self-efficacy. Knowledge about patient safety issues increased significantly after playing the game.

The aim of our study was to investigate user experiences, learning effect and impact on self-efficacy about patient safety. In addition, the evaluation outcomes were meant to be helpful in improving the game. The results suggest an increase of self-efficacy considering different aspects of patient safety. Students feel more confident about how to physically reduce their stress level if needed to get at ease in critical situations.

Our study has several limitations. As effects of AMS-1, we only measured low Kirkpatrick levels. We used self-reports of confidence in patient safety competencies. Self-assessment is known to be an unreliable measure of competence. On the other hand, aggregated self-assessment scores over 9-21 students have recently been shown to provide a reliable measure of program evaluation.(18) This provides some confidence that our aggregated self-efficacy measures reflect meaningful effect data. However, we cannot exclude that students feel they should be more confident about patient safety issues after having spent time playing a game with this purpose. This could have influenced self-efficacy post-test findings.
Another limitation of our study was the relatively small number of participants. Nevertheless, some outcomes measures showed significant effects.

A limitation of the external validity is that the male-female ratio of volunteering students in this study (1:12) is disproportional. In The Netherlands, the number of female medical students does exceed that of male medical students (3:2), but not to that extent. However, there is no indication that males would respond less favourably to gaming as an educational approach than females, which would decrease the external validity of our findings. One other limitation that we were forced to accept, is the difference in study conditions within the study group. Students could choose to play the game at home without supervision or at UMC Utrecht with the researcher around, and times between pre- and post-test differed. This may have influenced the outcomes. However, this situation can be representative for the use of the game as educational intervention, when a game might be played either in school or at home. Finally, this is not a controlled study. We did ask a limited number of other students (N=7) not playing AMS-1 to take the tests and make self-efficacy ratings with a time interval in the same time periode and found no or little increase. We considered this an indication that there was no reason to believe that other factors had contributed to our findings. However, to confirm our results, a more rigorous controlled investigation is needed. In addition, effects of playing this game on actual behavior change in a clinical setting must be studied.

AMS-1 fits well into the WHO intended curriculum about patient safety. The game gives information about patient safety, learn to act as a team player, during missions players manage clinical risks and much information is given about medication safety issues. It complements role playing and other traditional modes of teaching such as class room style lectures.

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