



# Transforming the Healthcare Simulation Spectrum: Now, Next and Beyond

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## ELECTRONIC SERIOUS GAMING – AN EFFECTIVE TRAINING TOOL FOR EMERGENCY RESPONSE IN PRIMARY CARE

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### Background

#### Preparedness for medical emergencies in primary care

Medical emergency cases occur unexpectedly in primary care. Primary care providers (PCPs) must be ready to respond and assess, stabilise and activate ambulance transportation to the nearest hospital where appropriate, in order to maximise the casualty's chance of survival and recovery. [1\*] Preparedness in primary care for such scenarios includes not only having the right equipment and supplies, but also training PCPs to have the right knowledge and skills to manage emergency cases. [2\*]

#### Emergency care training in Singapore primary care

Emergency care training in Singapore primary care can be conducted in didactic ways or practical ways. Didactic ways include traditional electronic learning (E-learning) modules, which cover factual, conceptual and procedural knowledge. Practical ways include Basic Cardiac Life Support (BCLS) and Automated External Defibrillator (AED) certification every 2 years and simulation sessions. These train psychomotor skills as well as teamwork skills. While BCLS and AED training can be applied to choking or arrested casualties, it does not cover medication delivery or peri-arrest management, of which simulation training can cover. [3]

#### Problem gap

PCPs significantly lack exposure and practice in handling medical emergencies. [4\*] Moreover, the reality of heavy workload and tight manpower needs faced by PCPs in many primary care practices makes it challenging to coordinate regular simulation sessions. [5\*] As such, there is a need to explore alternative modalities for training PCPs in emergency care knowledge application.

#### Serious gaming as an alternative training tool

In recent years there has been a trend towards serious gaming, which are full-fledged game products created to deliver training content. [6\*] Compared to traditional learning, serious gaming improves cognitive learning outcomes among health care providers, in terms of knowledge acquisition, content understanding, applying concepts and action-directed learning. [7,8\*] Serious gaming differs conceptually from gamification in that i) its primary aim is to create a game product to deliver training content, and ii) it is not intended to influence learner reactions towards the training content. [9,10]

### Electronic serious game prototype

#### “Acute Conditions & Emergencies in Primary Care”

“Acute Conditions & Emergencies in Primary Care” is an electronic serious game prototype designed for PCPs. The prototype was developed by a team of Family Physicians from SingHealth Polyclinics and game developers from Playware Studios using the ADDIE instructional design framework. [11] The objective is to apply emergency care knowledge to diagnose and treat medical emergencies in primary care. In-game, players take on the role of a primary care doctor stabilising a collapsed casualty. The 7 scenario gamelets are: hypotension from sepsis, severe asthma exacerbation, hypoglycemia, acute myocardial infarction, tension pneumothorax, seizure and vasovagal syncope. In order to successfully complete each scenario, the player must: 1) choose the correct tasks and delegate them accordingly, 2) based on the clinical findings, identify the medical emergency diagnosis by auscultating heart and lungs for abnormal auscultation findings and interpreting the vital signs and ECG, 3) choose the correct treatment(s) to stabilise the casualty, 4) choose the correct dose/delivery of the treatment(s), and 5) choose the correct disposition of the casualty.

#### Addressing the problem gap

Based on Adult Learning Theory (Knowles 1984) [12], PCPs are i) self-directed independent learners and ii) intrinsically motivated to learn knowledge that is relevant to their clinical work and enables them to prepare better for taking on emergency duty roles. Our electronic serious gaming prototype drives experiential learning (Kolb 1984) [13] among PCPs through in-game immersion with the medical emergency scenarios, helping to address their lack of exposure to emergency cases. It can be used by new PCPs or existing PCPs who want to practice applying their emergency care knowledge. Moreover, it has the advantage of being time flexible and allows training to be done remotely outside office hours, given PCPs' busy work schedules.

### Results of beta-testing

14 PCPs across 3 Polyclinics (Bedok, Marine Parade and Outram) participated in beta-testing between April-June 2021. Each participant was given a user account, user guide, as well as links to the software download and training video. Participants were given 2 weeks to complete the entire game and submit their evaluation. Evaluation was done using the Serious Game Design Assessment (SGDA) framework [14] – on the basis that serious games have purposes beyond the game itself, and that the game is considered cohesive and coherent if the non-game purposes are reflected in all game attributes. The results are summarised in the Table 1.

Game attributes	Description	Positive aspects	Areas for improvement
Purpose	What the game intends to achieve beyond the game itself	<ul style="list-style-type: none"> <li>92.9% (13/14) agreed that the game can be used as an emergency training tool and competency acquisition</li> <li>“Think it's a great idea to come up with a game for teaching of management of emergencies”</li> </ul>	
Content	Information, facts and data made available to the user	<ul style="list-style-type: none"> <li>85.7% (12/14) understood what they are tested on</li> <li>42.9% (6/14) were clear of what to do at every stage of the game</li> <li>64.3% (9/14) found the instructions adequate</li> <li>42.9% (6/14) found the instructions clearly written and helpful</li> </ul>	<ul style="list-style-type: none"> <li>Provide links to reading materials on the condition treated</li> </ul>
Mechanics	Gameplay possibilities (i.e. actions users can perform to interact within the game's set rules and algorithms), instructions or rewards	<ul style="list-style-type: none"> <li>28.6% (4/14) had trouble using the controls</li> <li>21.4% (3/14) had difficulty navigating in-game</li> <li>42.9% (6/14) were clear of what to do at every stage of the game</li> <li>Abile to choose gamelit (but not the scenario)</li> </ul>	<ul style="list-style-type: none"> <li>Some portions were repetitive</li> <li>Limited range of choices</li> <li>Lag time, having to redo games few times if answers not correctly ticked, sometimes not knowing the rights combinations to choose</li> <li>Not able to have an option to choose which scenario to practice</li> <li>Having a timer will be more realistic as most emergencies are time sensitive</li> </ul>
Fiction & Narrative	The created fictional space and its relation to the game's purpose	<ul style="list-style-type: none"> <li>85.7% (12/14) find that the game characters and objects resemble those at the workplace</li> <li>85.7% (12/14) can relate to the main character in the game</li> <li>85.7% (12/14) find that the environment and scenes are realistic</li> <li>Applicable real-life scenarios</li> <li>Realistic and guides us in thought process</li> <li>Had to think hard exactly what tests to order</li> </ul>	
Aesthetics & Graphics	Audiodisual display	<ul style="list-style-type: none"> <li>85.7% (12/14) find that the environment and scenes are realistic</li> <li>50% (7/14) found the game interface easy to use</li> <li>64.3% (9/14) found the background sound helped them be more engaged with the game</li> <li>Cool graphics</li> <li>“I like the part on the physical examination. It's quite realistic to hear the patient's heart rhythm and breath sounds... I like that the characters were wearing the SingHealth uniform – makes it more relatable.”</li> </ul>	
Framing	Adaptation of the other game elements to the topic, target user and their play literacy	<ul style="list-style-type: none"> <li>78.6% (11/14) were engaged in the game</li> <li>71.4% (10/14) found the game to be fun</li> <li>100% (14/14) found the game challenging to complete</li> <li>71.4% (10/14) agreed that their game result was a fair reflection of their skill competency</li> <li>85.7% (12/14) felt that their past experiences helped them overcome some of the game obstacles</li> <li>Challenging games</li> <li>Based on commonly encountered cases</li> <li>Relevant to primary care</li> </ul>	<ul style="list-style-type: none"> <li>Good to have greater range of scenarios (e.g. management of trauma case)</li> </ul>

Table 1 (above): Prototype evaluation using the SGDA framework

Participants were also asked to self-report outcomes of experiential learning. [15] This was done retrospectively 6 months after the trial user period. The results are summarised in Table 2.

Table 2 (to the right): Participants' self-reported learner outcomes

Learner outcomes	Description
Concrete experience	<ul style="list-style-type: none"> <li>80% (8/10) agreed that real-life medical emergency scenarios in primary care were realistically portrayed in the scenarios</li> <li>80% (8/10) agreed that the scenarios provided direct practical experience</li> </ul>
Reflective observation	<ul style="list-style-type: none"> <li>100% (10/10) drew connections from my existing knowledge while going through the scenarios</li> <li>100% (10/10) drew connections from their past experience of handling medical emergencies while going through the scenarios</li> <li>100% (10/10) became aware of the mistakes they made and learned from them in the process of attempting the scenarios</li> <li>80% (8/10) feel better prepared to handle medical emergencies in primary care after completing the scenarios</li> </ul>
Active experimentation	<ul style="list-style-type: none"> <li>90% (9/10) gained clarity on how to treat medical emergencies in primary care through after completing the scenarios</li> <li>70% (7/10) gained clarity on how to treat medical emergencies in primary care after completing the scenarios</li> <li>90% (9/10) feel more confident to handle medical emergencies in primary care after completing the scenarios</li> </ul>
Learner reactions	<ul style="list-style-type: none"> <li>80% (8/10) feel better prepared to handle medical emergencies in primary care after completing the scenarios</li> <li>60% (6/10) gained new knowledge on how to diagnose medical emergencies in primary care after completing the scenarios</li> <li>80% (8/10) gained new knowledge on how to treat medical emergencies in primary care after completing the scenarios</li> </ul>
Learner knowledge	

### Discussion

Overall, the game was found to be cohesive and coherent according to the Serious Game Design Assessment framework. Majority of participants reported components of experiential learning 6 months after the trial user period. As an emergency response training tool, electronic serious gaming is promising for Kirkpatrick level 2 effectiveness. Nevertheless, we acknowledge several limitations – including the likelihood of recall bias, limited reliability of self-reported outcomes, as well as unavailability of objective learning outcome measures at the time of beta-testing. We therefore aim to conduct a follow-up study to assess objective learning outcome measures.

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