

WGLN II Proposal May-06-05

SiMErgency: A Web-based Simulation of Medical Emergencies

for Training High School Students

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1. Rationale:

1.1. Educational Problem:

The concept of saving lives through the use of cardiopulmonary resuscitation (CPR) was a revolutionary idea during the 1960s. Today, nearly half a century later, CPR is a household word, and CPR classes have been taught to millions of middle and high school students, professional groups and laypersons around the World. However, many research studies assert that this huge effort has been less than fully effective. The studies show that those trained in CPR often fail to recognize emergencies and typically delay the initiation of CPR when emergencies are present (See ref.1 for a recent review).

The Save-a-Life Foundation report (2003) found among 43,600 Illinois students, aged 9–18, that over 90% retain theoretical parts of the initial training over several months when training included a personal workbook (2). Other reports indicate that students typically forget motor skills utilized in CPR within a 3-6 months period after initial training (3).

In a prospective, matched-control study of Year 6 (10-11 years) children (n=1292) only 4.1% of students retained the correct sequencing and assessment skills of Basic Life Support (BLS) techniques as demonstrated five months later using small portable manikins. This large study indicates that CPR training is not retained and that improved and effective methods must be designed for CPR instruction (4).

This educational problem is not restricted to schoolchildren. CPR capability is also sub-optimal in out-of-hospital rescue among paramedics (5), and in-hospital among nurses, medical students, and physicians (6). In a study of 298 nurses and nursing students in Helsinki, 97% failed, when tested on a mannequin to evaluate the pulse prior to initiating

CPR, 64% did not assess the patient's state of consciousness, and only 33% examined the patient's airway, even though 55% of this group believed that their CPR skills were good (7). Thus, despite existing educational guidelines, a major and pervasive training gap in health education persists and is the topic addressed by this proposal that offers a potential solution.

In summary, the problem with current CPR training is that the method provides excellent information, which unfortunately does not transfer to effective practice. Experienced researchers assert that CPR instructors need innovative teaching strategies to enhance learning.

1.2 Proposed Solution(s):

The key elements that require greater emphasis in the current training method are

- the ability to rapidly recognize medical emergencies
- the ability to determine the need for CPR and other appropriate first-aid interventions
- the ability to identify and recruit available resources (e.g. use of bystanders)

We hypothesize that providing contextual learning experience with simulation will be effective in overcoming the shortcomings of the current training model. The powerful emotional component of contextual learning experiences has been well documented and the use of simulations lends itself to repeated practice.

We believe a combined approach to teaching emergency preparedness that includes both CPR and first aid skills training and the cognitive component will help students learn to assess the situation and react quickly to medical emergencies. This will include topics such as appropriate use of available resources and effective communication skills. We

hypothesize that this combined approach will result in a more engaging learning experience as well as greater retention of the knowledge and skills over time.

Several studies have demonstrated that immersive and simulation based learning increases learner motivation and facilitates retention. Web-based instruction has the added advantage of being available 24X7 and it is easily accessed from geographically remote sites. Multi-user online games are becoming increasingly popular among high school students; therefore, we propose to design and use a multi-user simulation incorporating life-like emergency scenarios. This training medium would complement the current CPR training using video instruction and mannequins.

1.3 Background Literature

Educational research supports the use of situated learning for increasing motivation and retention among students. The greater emotional involvement during simulation-based learning has been acknowledged to be an important factor facilitating retention (8).

Simulation-based learning provides the opportunity for students to experience a variety of realistic medical emergency scenarios.

The Medical Emergency Response Plan for Schools (MERPS) is a widely endorsed, public health initiative for helping schools respond to life-threatening emergencies in the first minutes before the arrival of Emergency Medical Services (EMS) personnel (9).

Emergencies can result from pre-existing health problems, violence, unintentional injuries, natural disasters and toxins, and can happen in any school at any time. The MERPS provides guidelines for selection of training scenarios.

Many studies have reported the deterioration in performance of CPR within a few months after a course. This is true for laypersons, medics, physicians, nurses, medical students,

and other health care professionals, who do not perform CPR according to published guidelines. However, this conclusion is not surprising. Indeed, studies demonstrating poor retention of CPR skills have documented the poor performance of CPR for more than three decades (1). The January 19, 2005 issue of the JAMA indicates the urgent need to promote better CPR and improve the way CPR is taught. (1,5,6). Thus, despite existing curricular guidelines for California middle and high schools for ‘training students to proficiency’, a major and pervasive training gap in health education exists:

(California Educational Requirement: C P R
c e r t i f i c a t i o n m u s t c o v e r
i n f a n t - c h i l d a n d a d u l t C P R a s
w e l l a s c h o k i n g e m e r g e n c i e s
(A m e r i c a n R e d C r o s s
C o m m u n i t y C P R o r A m e r i c a n
H e a r t A s s o c i a t i o n B - l e v e l) .

1.4 Summary of Previous Work

Our previous work during the WGLN I grant period was the development and evaluation of a web-based, multi-user 3D World for team training in Emergency Medicine. We designed and created a Virtual Emergency Department trauma bay, using *Atmosphere* (from Adobe, Inc. San Jose, CA) and produced customized avatars to represent the health care team using *Poser* (from Curious Labs, Inc, Santa Cruz, CA). We scripted ten clinical scenarios and programmed the physiologically appropriate response for each. Then we conducted an experimental design study comparing the new method with a

previously validated mannequin-based simulator called the Human Patient Simulator. In pre and post test comparisons in WGLN I, the Swedish team showed improved behavioural components and gender differences in self efficacy after scenario-based training in the Human Patient Simulator (HPS). Similarly, the Stanford results showed improved team leadership performance after training on both the Virtual ED and the HPS simulation systems, and students reported an increase in confidence levels and high levels of immersion/realism with both systems (10).

The results of our WGLN I work have been presented at several conferences this year and a manuscript has been submitted for publication in *Presence*. (See list of presentations and publications in Appendix.). A direct consequence of our WGLN funding was the establishment of a sub-contractual relationship between the Stanford Team and Forterra, Inc. In November 2004 a Phase I Small Business Innovative Research (SBIR) grant of \$100,000 was awarded to create a multi-user web-based simulation to train “first responders” to meet the needs of medical disasters. Forterra’s online interactive virtual environments (OLIVE) platform was used for this development work – it has much greater functionalities and realism. The Forterra OLIVE environment, originally designed for the DoD to train soldiers for avoiding injury in war fights, has been re-purposed with new scenarios designed for civilian first responders at terrorist events.

CPR training is mandated at the high school level in both Sweden and California. In the proposed study, we will migrate the 3D World simulation-based learning approach to the pre-college level.

2.0 Target Population:

High School physical/health education students, ages 14–18 years, at the Huddinge Senior High School in Stockholm and Redwood High School in Northern California in the US.

3.0 Work plan

3.1 Specific Activities

The specific activities we propose to undertake are summarized below:

- Design 10 emergency response scenarios for use with high school students in the SiMErgency Simulation/Game
- Design the player interactions and scoring for the SiMErgency Simulation/Game
- Develop the scenarios, the player interactions and scoring using Forterra’s OLIVE development platform
- Conduct formative evaluation of the scenarios to assess realism and engagement with small groups of high school students in California and Sweden
- Conduct summative evaluation with classes of high school students in California and Sweden —half get the traditional approach, the other half get the SiMErgency game. Conduct both quantitative and qualitative assessments of their learning outcomes and emotional reactions to the learning experience.
- Analyze data, write final report, and publish results

3.2 Alignment with WGLN’s core objectives and goals

Based on our previous work in the design, development and implementation of simulation-based learning, we believe this project can be completed in the time period and will benefit both Stanford University and Karolinska Institutet, as well as the high schools involved in our study by demonstrating the value of a new way of teaching high school students, college students and the general public how to respond quickly and effectively to the common medical emergencies they are likely to experience in their lives. We also think this innovative use of ICT will be useful as a complement to the traditional approach to teaching CPR and could become more widely adopted by the American Heart Association and the International Red Cross Association.

3.3 Process Results

As a result of our successful collaboration during WGLN I, the Stanford and Swedish teams have an excellent rapport and working methodology. We have established close communication using telephone, video conferencing, meetings at conferences, and emails. Both collaborators have identified schools in close proximity to their universities and have gotten the cooperation of high school teachers and principals responsible for the health education curricula.

3.4 Project outcomes and Curriculum Integration

The project outcome will include a new simulation-based training method that complements current mannequin-based CPR training in schools. We anticipate successful implementation of our new method in high schools both in US and Sweden by August 2006.

3.5 Workplan Timeline

- Months 1-2 (summer 2005) High school science and Physical/Health education teachers work with research team to design five scenarios appropriate for students in CA and Sweden. Swedish teachers will translate the scenarios into Swedish and CA teachers adapt the scenarios for the US context, and the US teacher seeks to translate into Spanish for her Hispanic students.
- Months 3-6 Development of the first 5 scenarios in Forterra's OLIVE platform and pilot test the scenarios with students at high schools in CA and Sweden (lab type study; formative only)
- Months 7-8 Conduct experimental study with volunteer students in CA and Sweden using the first 5 scenarios and assessing their anxiety, coping, etc. characteristics with questionnaires.
- Month 7-10 Simultaneous development of 5 additional scenarios in Forterra's OLIVE development platform.
- Month 10-11 Conduct experimental study with the same volunteer students in CA and Sweden using the 5 additional scenarios and assessing performance for retention of the knowledge and skills over time.
- Month 12 – Data Analysis and report writing

4.0 Evaluation

4.1 Evaluation Plan

Phase 1: Design and Development of Scenarios for the SiMERgency Game. The physical/health education teachers and research team at SU and at KI will produce 5 scenarios at each study site—Redwood City and Stockholm. Each team will conduct a

formative evaluation of the scenarios with 2-3 students from the target audience to ensure they are realistic and engaging. The products will be the completed scenarios.

Phase 2: Development and testing of the SiMErgency Game

Summative evaluation of the SiMErgency Game will take place in existing health education or science classes at each study site. Volunteers will be sought to participate in one of two groups—those who receive traditional CPR training that is complemented with the SiMErgency Game and those who receive the traditional CPR training (videotape and practice on a mannequin) that is complemented with additional videotaped instruction (as a ‘placebo’). Those in the treatment group will be divided into four person teams who will participate in one scenario at a time, until each team has completed all 10 scenarios. This will take place during the spring semester between February and April 2006. Learning outcomes will be assessed on a multiple choice test (the traditional test) as well as an assessment of their performance on their final scenario. All subjects in the treatment group will be asked to complete several questionnaires (see below) and participate in a focus group discussion after the training to provide their opinions of how well it worked. This protocol will be followed at the high schools in Stockholm and in California. Results will be analyzed and compared to see if there are significant differences between the treatment and control groups.

4.2 Evaluation Logic and Instruments

Several instruments for assessing learning outcomes (e.g. assessment of team leadership using a behaviorally anchored rating scale) have been validated in our prior work and will be adapted for use in this study.

We will assess changes in students' knowledge, skills, attitudes and behaviors before and after using the prototype educational game. We predict improved learning outcomes (performance) from models of engagement-modes, self-efficacy, flow experience, locus of control, and proactive coping. We will use the General Perceived Stress Questionnaire (PSQ) to measure perceived stress and the State-Trait Anxiety Inventory (STAI) to assess anxiety during training in each scenario. The stronger the anxiety trait, the more likely it is that the individual will experience elevations in state anxiety in threatening situations. The evaluation logic of this research is as follows: High personal resources (i.e. high self-efficacy beliefs, positive engagement modes, internal locus of control, proactive coping, low perceived stress and anxiety) as well as training resources (social support climate and clear goals) facilitate training-related flow (training absorption, training enjoyment, and intrinsic motivation). The training-related flow will, in turn, have a positive influence on team and leadership performance. We also anticipate gender and age differences on these measures.

5.0 Collaboration and integration:

The collaboration between the Karolinska Institutet, Umea University, and Stanford University groups, including their teacher colleagues will work together to design scenarios appropriate for both cultures; Swedish teachers and investigators will translate the language for Sweden. A Stanford science outreach program has offered initial support for a teacher to work four days weekly for eight weeks during which the scenarios will be designed and developed jointly with a teacher in Sweden. Weekly phone and/or video-conferences will maintain the necessary communication for

producing an integrated set of applications to be implemented during the evaluation phase in 2006.

6.0 Staffing

A brief description of the key project staff at each Institution, including their responsibilities follows.

Staffing: Stanford

Wm.LeRoy Heinrichs, MD, PhD – Co-PI

Patricia Youngblood, PhD– Co-investigator

Sakti Srivastava, MBBS, MS– Co-investigator

Kingsley Willis, BA – artist/designer

Robert Cheng, MEng. – programmer

Kim M. Hansen – High School Biology Teacher

Matt Kaufman, VP Forterra, Inc –Gaming Consultant

Staffing: Huddinge Hospital (Karolinska)

Li Felländer-Tsai, MD, PhD – Co-PI

Carl-Johan Wallin, MD, PhD – Co-investigator

Johan Creutzfeld, MD, Anesthesia consultant

Christofer Medin, MEng - Co-developer

Ylva Lokander, Principal at Huddinge SHS

Karl Stengård, Science teacher at HSHS

Jan Palmblad, MD, Prof. Med.–Cardiology

Björn Eriksson, MD, PhD, Prof. Med.–Cardiology

Staffing: Umeå

Leif Hedman, PhD – Co-PI

7.0 Sustainability

As a result of our WGLN I and Forterra projects, we have begun discussions with the local chapter of the American Red Cross and the American Heart Association. These organizations have expressed great interest in using this approach in their training programs. We are encouraged by this initial interest and support. If awarded a WGLN II grant, we will have evidence supporting the value of extending this training approach to a larger audience of learners. Recommendations from the collaborating high schools will be instrumental in wider dissemination throughout the local and regional school districts.

References:

- 1) Arthur B. Sanders and Gordon A. Ewy Cardiopulmonary Resuscitation in the Real World: When Will the Guidelines Get the Message? *JAMA*. 2005;293:363-365.
- 2) http://www.salf.org/library/pilot_research.aspx Accessed 2005 05 01
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- effective life support skills in children? *Resuscitation*. 2002 Dec;55(3):255-61.
- 5) Wik L, Kramer-Johansen J, Myklebust H, et al. Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. *JAMA*. 2005;293:299-304
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 - 7) Nyman J, Sihvonen M. Cardiopulmonary resuscitation skills in nurses and nursing students. *Resuscitation*. 2000 Oct;47(2):179-84.
 - 8) Bonwell CC, Eison JA: *Active Learning: Creating Excitement in the Classroom*. ASHE-ERIC Higher Education Report 1. Washington D.C: George Washington University. 1991, p.20.
 - 9) <http://www.americanheart.org/presenter.jhtml?identifier=3017969> Accessed 4-29-05.
 - 10) Youngblood P, Srivastava S, Harter P, Dev P, Wallin C-J, Tsai L, Heinrichs WL (2005), *Validation of a web-based VR simulation for training trauma teams*, Medicine Meets Virtual Reality (MMVR) 2005 Conference, Long Beach, CA USA, January 2005.

Appendix : WGLN I Publication and Presentations

- 1) Srivastava S, Harter P, Youngblood P, Wallin C-J, Fellander-Tsai L, Moffett S, Heinrichs WL, *A Web-based Virtual 3D World for Team Training in Emergency Medicine Crisis Resource Management (EMCRM)* Submitted to Presence, April 2005
- 2) Youngblood P, Harter P, Srivastava S, Heinrichs WL, Dev P, *A Virtual Learning Environment for Team Training in Trauma Management*, accepted as one of 20

Innovations in Emergency Medicine Education (IEME) exhibits at the Annual Meeting of the Society for Academic Emergency Medicine, New York, NY, May 22-25, 2005

- 3) Srivastava S, Harter PM, Youngblood P, Wallin CJ, Fellander-Tsai L, Moffett S, Heinrichs WL. *A Virtual 3D World For Team Training in Emergency Medicine Crisis Resource Management (EMCRM)*. Western Regional Society for Academic Emergency Medicine, Marina Del Rey, CA, April 2005.
- 4) Youngblood P, Srivastava S, Harter P, Dev P, Wallin C-J, Tsai L, Heinrichs WL (2005), *Validation of a web-based VR simulation for training trauma teams*, Medicine Meets Virtual Reality (MMVR) 2005 Conference, Long Beach, CA USA, January 2005.
- 5) Srivastava S, Harter P, Youngblood P, Dev P, Wallin C-J, Tsai L, Heinrichs WL (2005), *A web-based virtual 3D world for team training in trauma management* Medicine Meets Virtual Reality (MMVR) 2005 Conference, Long Beach, CA USA, January 2005.
- 6) Harter P, Youngblood P, Moffett S, Srivastava S, Heinrichs W L, Dev P (2005), *Comparison of Student Perceptions of Web-based Virtual Reality vs HPS Simulation Training in Trauma Management*, presented at the 5th Annual International Meeting on Medical Simulation (IMMS), Miami, FL, USA, January 2005
- 7) Tsai L, Wallin CJ, Youngblood P (2004), *Design, Development and Evaluation of Emergency Medicine Cases for the Human Patient Simulator (HPS) and Virtual ED Simulation Systems*, presented at the Wallenberg Global Learning Network (WGLN) 2004 Symposium, Stockholm, Sweden, October 2004

