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14. ABSTRACT
Medical triage in mass casualty or trauma events is an area where decision-making is vital for achieving positive outcomes. It is necessary that first responders and medical personnel are thoroughly trained and prepared for action; however, there are few opportunities to obtain the training and experience necessary for optimal performance in mass casualty emergency situations. Considering homeland defense needs, there is a large number of personnel that require training. Two simulation training platforms can be applied to triage training and assessment: manikin training and virtual reality (VR) scenarios. Manikin training provides realistic hands-on training, which is particularly geared for students without experience, or for those demonstrating competency for certification. Since VR systems have less hands-on capability, they work well for initial training as a lead into manikin training, or as refresher training for cognitive triage skills. Phase I of this proposal is to determine the effect of manikin training in acquiring triage skills and self-efficacy. Phase II includes the development of the VR training scenarios, which includes iterative usability testing.

15. SUBJECT TERMS
Triage, mass casualty, homeland defense, simulation, virtual reality, manikin, usability

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Introduction

Medical triage in mass casualty or trauma events is an area where decision-making is vital for achieving positive outcomes. At a disaster site, triage may be the most important medical task performed.(3) It is vital that first responders and medical personnel are thoroughly trained and prepared for action; however, there are few opportunities to obtain the training and experience necessary for optimal performance in mass casualty emergency situations.

Simulation technology can provide a solution for the need to train triage by providing readily available cognitive and procedural training platforms that can supplement a didactic triage curriculum. In addition to skills training, simulation exercises can help lower psychological barriers in stressful emergency situations by providing a safe controlled environment for practice.(2) Similar to the value of flight simulators for pilots, medical simulators permit both physical and mental skills development and maintenance for health care providers.

The SimCenterHawaii: Technology Enabled Learning and Intervention Systems project has proposed two simulation training platforms that can be applied to triage training and assessment: manikin training and virtual reality (VR). Manikin training with computerized life-size manikins provides realism, as diagnostic assessments and therapeutic interventions must be manually performed, in addition to cognitive decision making. As such, training on manikins may be more relevant for untrained learners as medical or allied health students. However, even for trained and practicing providers, manikin scenarios serve as excellent methods to assess competency for course completion or certification. In summary, we have proposed that manikins can be utilized in triage training for several purposes: a) initial and subsequent training (with or without previous VR training) for both procedural and decision-making skills, and b) competency assessment of both procedural and decision-making triage skills.

Virtual reality (VR) scenarios such as those used in video games have the advantage that after development and evaluation, it can be distributed to a large audience through computer-based programs with less of a need for on-site educators. The virtual environment can be designed to mimic battlefield or mass casualty settings, and trainees can go through the steps of triage and be graded by the computer. A VR triage curriculum would be an excellent method to develop, assess, and provide longitudinal training for providers like emergency medical technicians, who would not require practice of basic patient stabilization procedures, since they use them on a daily basis. It would be more important to practice their decision-making skills in a mass casualty scenario, which they don’t see on a day-to-day basis. With this in mind, the VR training platform for triage could be used for several purposes: a) initial training for those without any experience as prelude to manikin training, and b) refresher training between intervals of manikin training, and c) competency assessment of decision-making skills.

The SimCenterHawaii's Technology Enabled Learning and Intervention Systems program ties together a didactic curriculum, online computer-assisted scenarios, manikin simulation, and VR training. The online curriculum potentially reduces the time and cost necessary to train at the center, saving valuable personnel resources (teacher and learner) for operational needs. Training with manikin and VR simulations facilitate access to working with “life-like” patients. Triage in an immersive VE can simulate decision-making in a stressful field environment, while providing first responders with the experience needed for life and limb sparing care

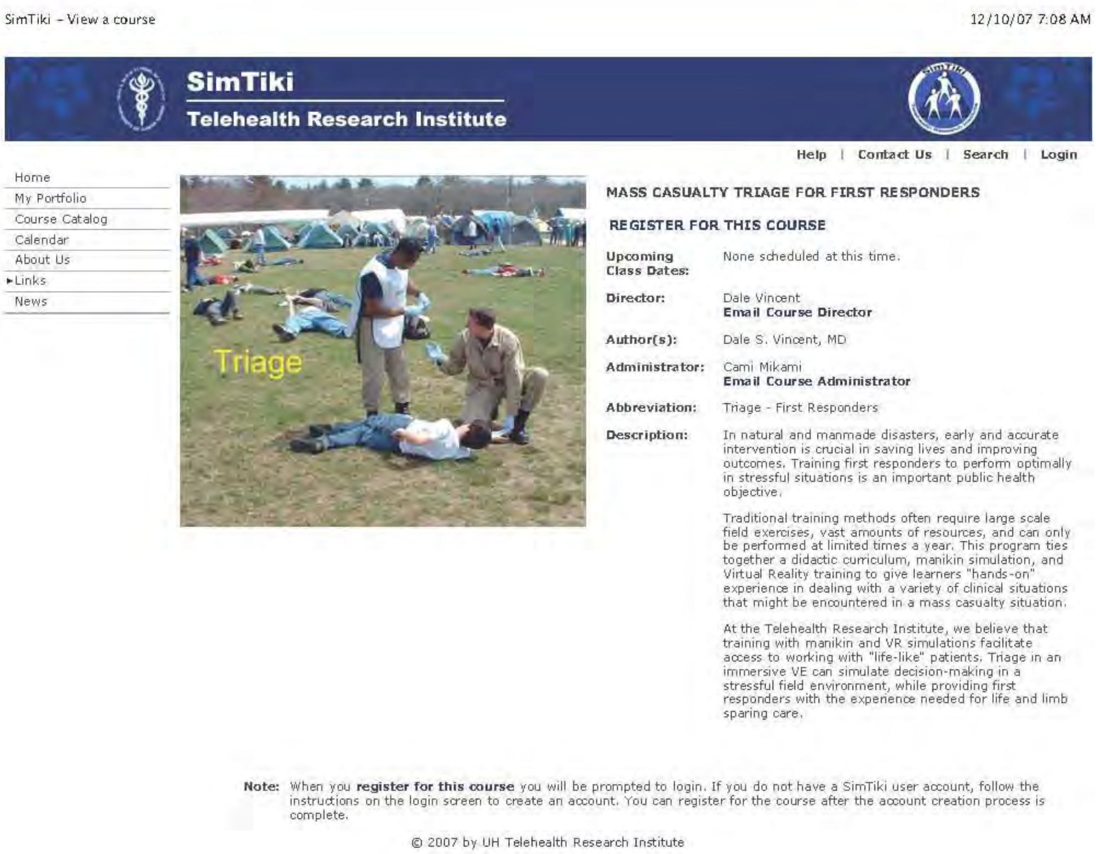
Body

Task A. Phase I, Manikin Training for Acquisition of Triage Skills

Task A1. Develop online triage course

The initial plan was to use the Sakai Learning Management system, a popular open-source LMS commonly used in university settings. Initial trials using the software were successful; however, the course material was corrupted and lost when Sakai issued an upgrade. Because of the perceived instability of the software, we decided to utilize SIMS, the University of Pittsburgh's WISER Institute's LMS. The LMS is able to manage all of the survey instruments except for the ungraded pretest (only one pretest is permitted in the system). See Figure 1 for screenshot of Mass Casualty Triage Course, located at http://simtiki.simmedical.com/apps/courses/courseview.asp?course_id=6142

Figure 1. Screen shot of the online Mass Casualty Triage Course



Content for the course were created as four podcasts, created using ProfCast 2.1 software. (total of 19:35 minutes): 1) Introduction to Manikin Simulation (3:57 minutes), 2) Triage Basics (4:53 minutes), 3) Triage Challenge I (5:00 minutes), and 4) Triage Challenge II 5:45 minutes). Students were asked to rate the podcast instructional material in these areas, using Likert scales (strongly disagree to strongly agree). In addition, a triage quiz was created to test knowledge acquisition (see *Appendix A*).

Item	Average	SD
1. Material was relevant to my duties as a healthcare provider (1SD -7 SA)	6.3	0.7
2. Course objectives were adequately explained (1SD -7 SA)	6.1	0.9
3. Course was well organized (1SD -7 SA)	6.4	0.8
4. Material was interesting (1SD -7 SA)	6.4	0.8
5. Course communicated material effectively (1SD -7 SA)	6.5	0.7
6. My questions were answered (1SD -7 SA)	6.6	0.7
7. Pace of the course (1=too slow, 7=too fast)	4.5	0.8
8. Level of difficulty (1=too hard, 7=too easy)	4.0	0.7

The results indicated that the learners thought that the course material was highly relevant, organized, interesting, and communicated effectively using the podcast format. Additionally, the pace of the podcast material and the level of difficulty was judged as "just right."

Task A2. Program manikins

The Laerdal SimMan manikins and Laerdal SimBaby manikin were used for the manikin training study. Three groups of five manikins represented simulated casualties. Each group consisted of 3 "immediate," 1 "minimal", and 1 "delayed" or "expectant" simulated casualties. Each group included these "immediate" injuries: one hemorrhagic shock, one tension pneumothorax, and one airway management problem. "Delayed" casualties included a patient with a leg fracture, and a patient with blunt abdominal trauma. The "expectant" casualty had massive head trauma. "Minimal" patients had minor wounds with normal vital signs. Main abnormalities fell into these categories: airway, breathing, circulation, neurologic, and other. Intervention options included applying a tourniquet, using a HemCon bandage, performing a needle decompression, and inserting a nasopharyngeal airway. In some instances, "no intervention" was the appropriate response. See *Appendix B, Manikin Scenerios* for details of each of the scenarios. *Appendix C, Manikin Triage Setup* contains further details on programming the manikin. In addition to the programming, to add realism, props, such as bloody cloths and bandages, were constructed to provide critical clues for assessing the patients (See Figure 2).

Figure 2. Manikins and props

Task A3. Conduct all appropriate procedures with institutional review boards

IRB for both *Task A- Manikin Training for Acquisition of Triage Skills* and *Task B – Development of Virtual Reality Triage Application* were submitted and determined expedited by the University of Hawaii Committee on Human Studies and The Human Research Protection Office, Office of Research Protections U.S. Army Medical Research and Materiel Command, Ft. Detrick. Both Univeristy of Hawaii and Ft. Detrick has approved the protocol and all modifications (see *Appendix D and E* for protocols).

Task A4. Conduct acquisition of triage skills study

See *Appendix F, Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders* for details

Task A5. Skills acquisition relative to self-efficacy study

See *Appendix F, Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders* for details

Task A6. Analyze data and publish results

See *Appendix F, Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders* for paper in progress

Task B. Phase II, Development of Virtual Reality Triage Application

Task B1. Develop virtual reality application with five avatars

See Appendix G, *Design and Development of a Pose-Based Command Language for Triage Training in Virtual Reality* for detailed description of the technical design and development the VR Triage application

Task B2. Conduct all appropriate procedures with institutional review boards

See Appendix D and E for approved protocols

Task B3. Conduct heuristic usability study and publish results

See Appendix H, Using a Heuristic Evaluation model for the Development of Virtual Reality Triage for paper in progress

Key Research Accomplishments

<u>Task A. Phase I, Manikin Training for Acquisition of Triage Skills</u>

Task A1. Develop online triage course

- Online course
  http://simtiki.simmedical.com/apps/courses/courseview.asp?course_id=6142
  - Triage Quiz
  - Training podcasts
    1) Introduction to Manikin Simulation (3:57 minutes)
    2) Triage Basics (4:53 minutes)
    3) Triage Challenge I (5:00 minutes)
    4) Triage Challenge II 5:45 minutes).

Task A2. Program manikins

- Three triage scenarios with five manikin s each have been developed, to include requirements for moulage of manikins, simulation requirements, physiology, assessment, and intervention (see Appendices B, Manikins 1-5)

Task A4. Conduct acquisition of triage skills study

- See *Appendix F, Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders* for paper in progress

Task A5. Skills acquisition relative to self-efficacy study

- See *Appendix F, Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders* for paper in progress

Task A6. Analyze data and publish results

- See *Appendix F, Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders* for paper in progress

<u>Task B. Phase II, Development of Virtual Reality Triage Application</u>

Task B1. Develop virtual reality application with five avatars

- The following are research accomplishments in the technical development of VR Triage development:
  - VR-Triage utilizes a generic character setup for its virtual patients, which allows fast cloning of characters to create new cases, in scenarios with massive casualties.
  - The sequential nature of triage (one patient at a time) allows using high quality models with complex and computationally expensive internal controls without degrading speed of animation. For example, the latest model in the patient pool has over 4,000 polygons for the face area. To compare, a lead character from Final Fantasy X video game has 3,000 polygons.
  - VR-Triage is using in-house developed technologies, which gives full control over the appearance and behavior of the virtual patients and full flexibility in

designing user-interface controls. There are no dependencies on third-party libraries or game engines.

- The system is scalable from a desktop case (i.e. laptop) to fully immersive case (HMD and motion tracking). For developing convenience, most immersive interface metaphors have their desktop analogues, which allow programming and optimizing code without the use of expensive hardware, such as motion tracking systems.
- There are 4 different scenes developed for triage training, showing various in-doors and outdoors settings. The settings can be customized on per-object basis, including geometric props, light sources, sound effects and human characters.

Task B3. Conduct heuristic usability study and publish results

- See *Appendix H, Using a Heuristic Evaluation model for the Development of Virtual Reality Triage* for paper in progress

Reportable Outcomes

- **Presentation** - February 2007, Medicine Meets Virtual Reality conference, Long Beach, CA, *Virtual Reality Environments for Medical Training and Therapy: Surgical Skills Acquisition, Virtual Beach, Virtual Patient and Virtual Nephron (Appendix I)*
- **Presentation** - March 2007, IEEE VR Conference, Charlotte, North Carolina paper presentations, published in conference proceedings
    - *Design and Development of a Pose-Based Command Language for Triage Training in Virtual Reality(Appendix G)*
    - *Optical Sight Metaphor for virtual Environments(Appendix K)*
- **Presentation** - June, 2007, First Annual Japan-America Symposium in Acute Care Medicine, Terumo Pranex East, Odawara, Japan, *Mass Casulty Triage Training using Manikin Simulation (Appendix J)*
- **Presentation** - July, 2007, HCI International 2007 Conference, Beijing, China paper presentation, *Assessing the Real-Time Cognitive Capabilities of First Responders Using Emerging Technologies in Manikin Simulators (Appendix L)*
- **Publication** - Connolly KK, Burgess L. (2007). *Assessing the Real-Time Cognitive Capabilities of First Responders Using Emerging Technologies in Manikin Simulators.* In Schmorrow D, Reeves L (Eds.), Foundations of Augmented Cognition. (pp. 314-322). Berlin: Springer. *(Appendix M)*
- **Survey Results** – August, 2007, Asia Pacific Nursing Forum Workshop, Honolulu, HI *(Appendix N)*
- **Presentation** – *Manikin Triage Simulation* presentation for general use *(Appendix O)*
- BAA06 – Proposal - *SimCenter Hawaii: Virtual Reality Applications for Health Care Education and Training*
- **Publication (in progress) -** *Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders (Appendix F)*
- **Publication (in progress) -** *Using a Heuristic Evaluation Model for the Development of Virtual Reality Triage (Appendix H)*

Conclusions

Due to the complexity of setting up moulage field exercises that focus on mass casualty triage, medics and first responders often receive limited training. Creative training solutions must address the need for advanced training of health care teams and individual providers in ways that are timely, efficient, reproducible, and able to be delivered through existing training networks. Simulator-based training can be a solution and has been shown to improve outcomes for both cognitive as well as motor-skills training.(1)

Our research within this proposal strives to further develop and demonstrate that simulation training with virtual reality software and/or manikins can not only better meet training objectives than with a didactic curriculum alone, but provide a hands-on alternative to moulage field exercises in a less expensive and more readily available platform. Both manikin-based and virtual reality training curriculums can be integrated into a multidisciplinary training program to enhance the training of first responders.

Through this proposal, we have conducted the following studies:

- *Manikin Triage Training* –This research study that will help us understand the optimal conduct of triage training using manikin simulators, and that packaging and disseminating sophisticated manikin-based online curricula can used as a more readily available and less expensive alternative to mass casualty triage training.

  Results – In this study, we demonstrated that novice First Responders were able to demonstrate the successful acquisition of mass casualty triage skills after two successive iterations of hands-on exposure and directed feedback. The learners improved significantly in their ability to correctly tag the patients and intervene appropriately. Furthermore, in addition to demonstrating improved accuracy, the learners worked significantly faster. Of importance to educators, the addition of a third scenario consisting of five more simulated patients to triage reliability improve the learner's speed or accuracy. This finding has implications for planners and course directors, since the training time can be shortened by approximately one-third.

- *Heuristic Usability Evaluations* - The software development and evaluation model that we have developed consists of two iterations of expert heuristic testing and one evaluation using typical users of the system. As key to the success of VR Triage, it is vitally important that the application is usable and able to satisfy the needs of the training, without hindrance of the technology itself. Therefore, in the development process of VR Triage, we have developed and utilized a heuristic usability evaluation model.

  Results – The results showed an improvement trend across the three evaluation groups. The user evaluation, which took place after the expert heuristic evaluations, demonstrated the least amount of usability problems. The overall trend in the reduction of usability issues found in the expert evaluations and the user evaluation demonstrates that the iterative process of usability testing did improve the user interface of the VR Triage software.

In conclusion, training with manikin and VR simulations can facilitate access to working with “life-like” patients. Triage in an immersive VR application can simulate decision-making in a stressful field environment, while providing first responders with the cognitive experience needed for life and limb sparing care. On the battlefield, it is essential to assess, triage, and treat medical emergencies accurately, proficiently and in a timely manner. Physical examination skills, especially determination of shock and respiratory compromise, are crucial. The skills and clinical judgment required for these critical life or death decisions cannot be acquired without training involving “real patients,” whereby the soldier trainees can learn the actual physical techniques, risks, and benefits inherent in the critical procedure. Both manikin and VR simulations facilitate accessibility to training on “life-like” patients, thereby providing invaluable practical experience for combat medics and medical personnel. The Telehealth Research Institute (UCERA) will continue to research, develop and investigate simulation technology with the objective to improve the ability to train utilizing new emerging technologies.

References

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2. Hendrickse AD, Ellis AM, Morris RW. Use of simulation technology in Australian Defence Force resuscitation training. J R Army Med Corps 147: 173-8, 2001.

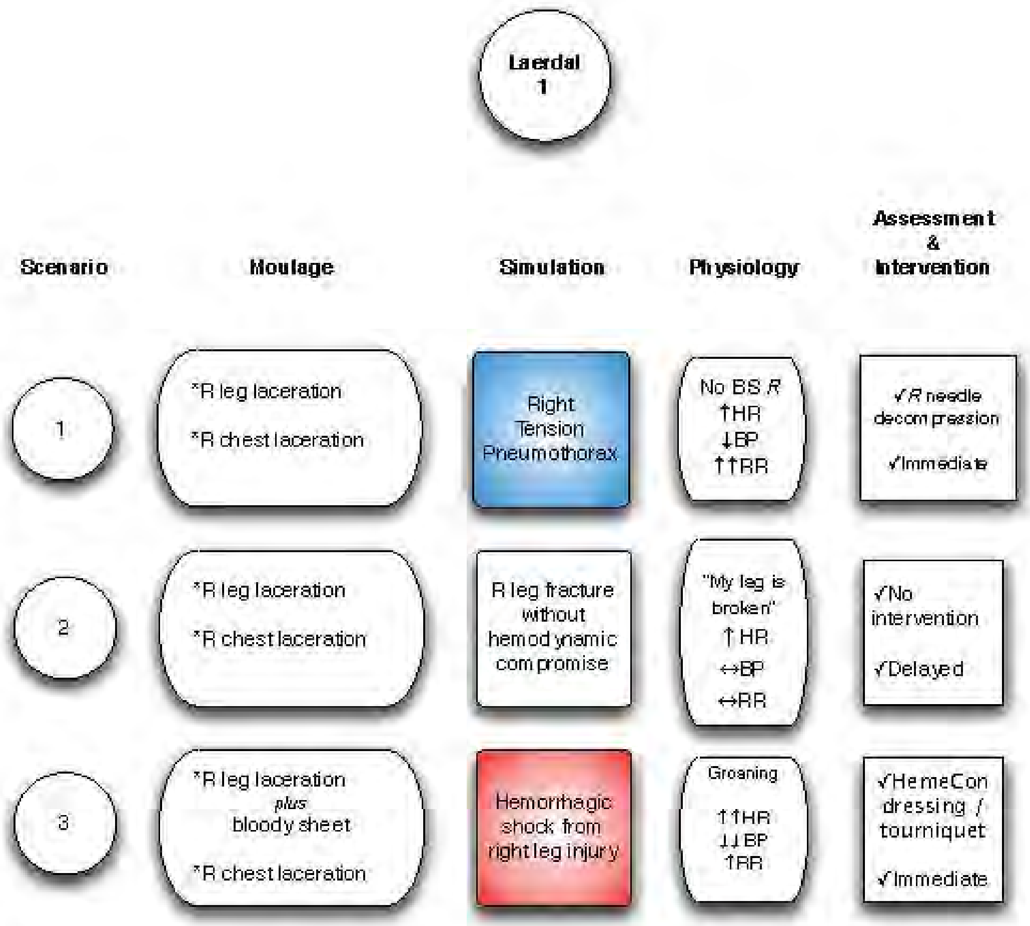
3. Waeckerle JF. Disaster planning and response. New England Journal of Medicine 324: 815, 1991.

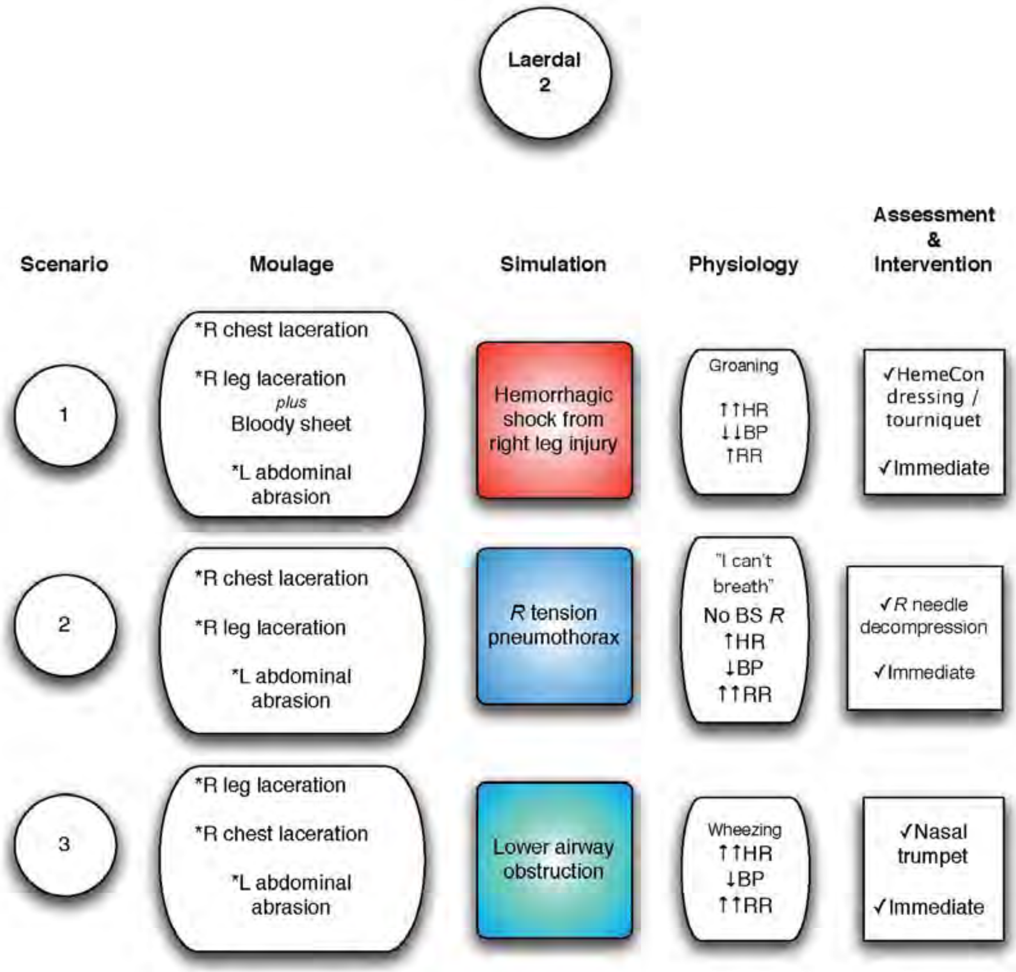
Appendices

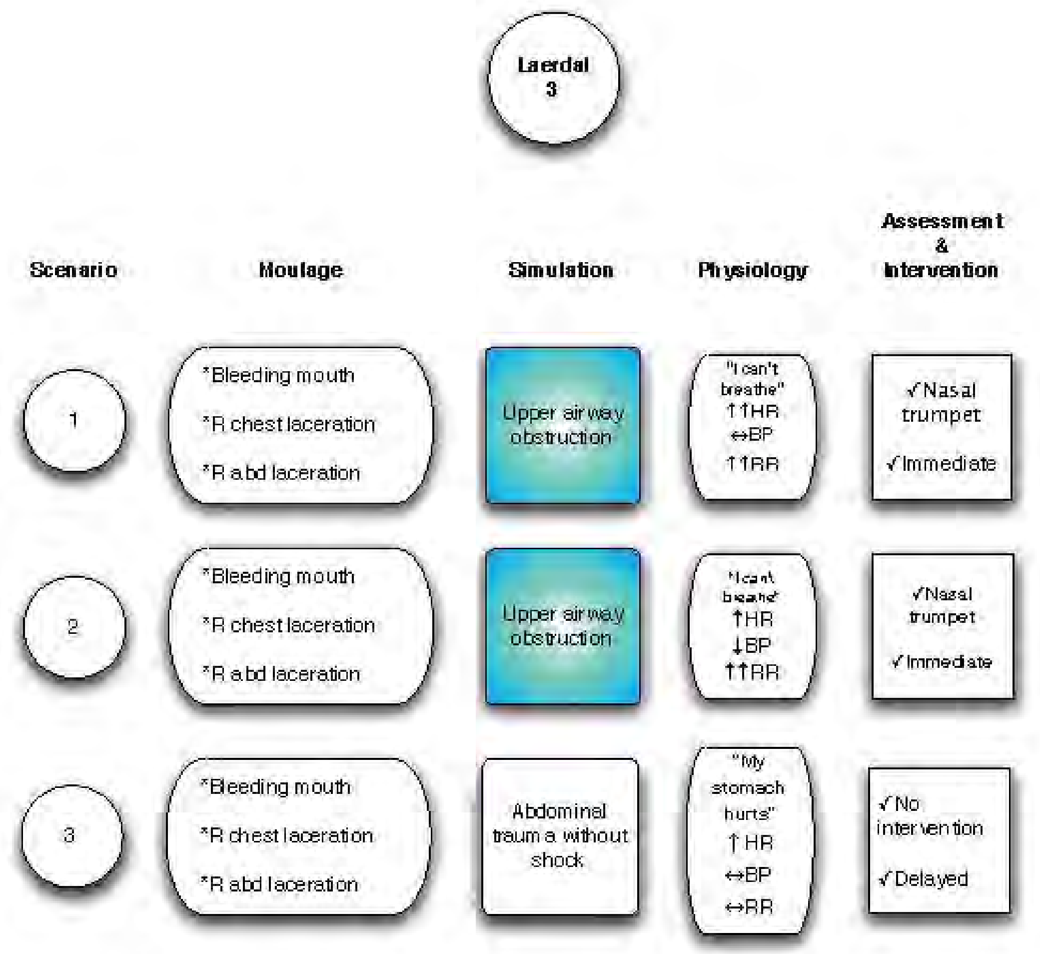
Appendix A
Triage Curriculum Quiz

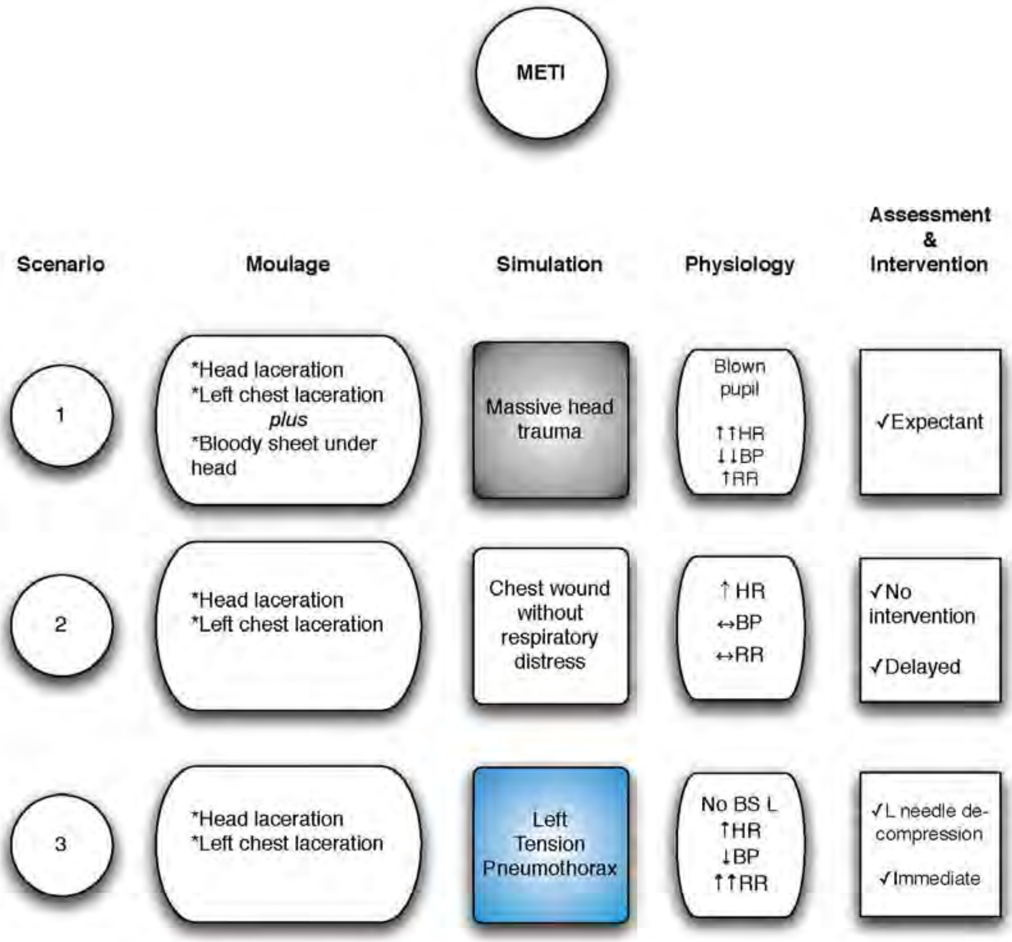
T	F	1.	Needle decompression is a dangerous maneuver and should only be used after verification of breath sounds, tracheal deviation, and hyperresonance.
T	F	2.	Obtaining accurate vital signs is an essential element of mass casualty triage.
T	F	3.	Nasopharyngeal airways are better tolerated than other oral airways in patients that may regain consciousness.
T	F	4.	Penetrating neck injuries, by definition, require c-spine immobilization.
T	F	5.	Life threatening hemorrhage from major extremity injuries are best managed by hemostatic dressings or QuikClot powder.
T	F	6.	Endotracheal intubation is the gold standard for field intubation in mass casualty situations.
T	F	7.	Temporary tourniquets should not be used for extremity trauma because the irreversible risk of limb ischemia is unacceptable after one hour of treatment.
T	F	8.	Combitubes are effective even if inserted blindly.
T	F	9.	Venting of an occlusive dressing is absolutely essential when closing a traumatic chest injury in a mass casualty situation.
T	F	10.	Placement of a chest tube must be performed soon after needle decompression, because of the risk of reaccumulation of a tension pneumothorax.
T	F	11.	Placement of a chest tube is likely to result in reinflation of the affected side of the chest with penetrating injury.
T	F	12.	Normal mentation is usually adequate to verify adequate perfusion.
T	F	13.	Normal mentation is necessary but not sufficient to verify adequate perfusion.
T	F	14.	Obtaining a blood pressure is absolutely essential in the initial managment of the trauma victim.
T	F	15.	A palpable radial pulse and normal mentation are acceptible end points for adequate fluid resuscitation.
T	F	16.	Patients without maxillofacial injuries are much less likely to have compromised airways.
T	F	17.	Early control of hemorrhage is essential since hypovolemic shock can occur very quickly.
T	F	18.	Following a blast, a patient who is found to have no pulse should have CPR begun immediately, since patient 's heart is probably "stunned," and the probability of successful resuscitation is high.
T	F	19.	The airway of choice in a patient with significant maxillofacial injuries is a crichothyroidotomy.
T	F	20.	Removal of clothing at the site of injury is critical in order to expose all possible wounds.
T	F	21.	All patients with wounds should have fluid resuscitation begun as soon as practicable, to forestall the possibility of shock from unrecognized trauma.
T	F	22.	Unconscious patients without airway obstruction still need airway protection, preferably with an easily inserted device such as a nasopharyngeal airway.
T	F	23.	Unconscious patients should never be repositioned, since unrecognized injuries may be made worse from the repositioning.
T	F	24.	A patient who is categorized as "delayed" may require stabilization, but would not be expected to deteriorate for several hours.
T	F	25.	Patients who are categorized as "minimal" should be capable of self-aid.
T	F	26.	"Expectant" in a crisis situation is synonymous with "no treatment."
T	F	27.	"Expectant" patients require the utilization of maximal resources in order to undo the effects of catastrophic injury.
T	F	28.	"Expectant" means that the patient would be expected to survive if appropriate resources were put toward their urgent care.
T	F	29.	The categories of "routine" and "minimal" are basically synonymous in the lexicon of triage.
T	F	30.	Initial mass casualty triage involving dozens of casualties following an urban blast would most likely to emphasize the principle of "prevent further harm."

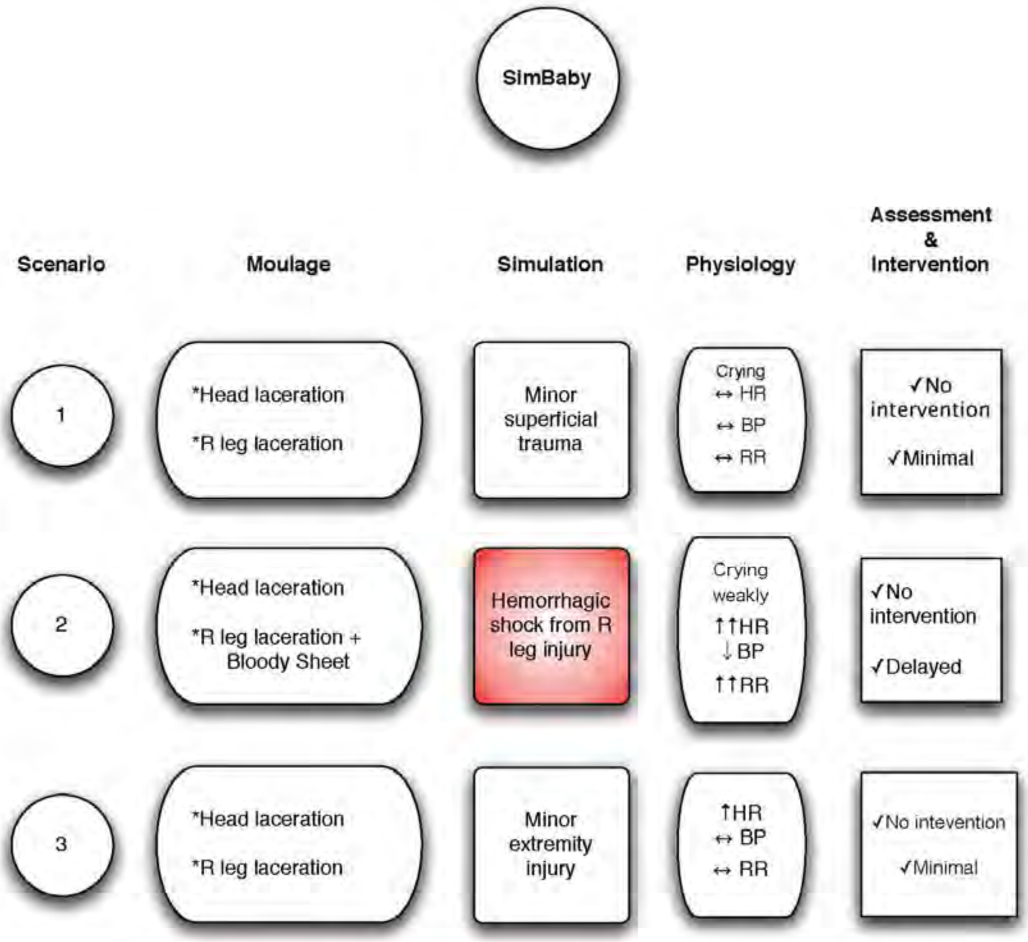
Appendix B
Manikin Scenarios


Laerdal 1
Scenario
Moulage
Simulation
Physiology
Assessment & Intervention
1
*R leg laceration
*R chest laceration
Right Tension Pneumothorax
No BS R
↑HR
↓BP
↑↑RR
√R needle decompression
√Immediate
2
*R leg laceration
*R chest laceration
R leg fracture without hemodynamic compromise
"My leg is broken"
↑HR
↔BP
↔RR
√No intervention
√Delayed
3
*R leg laceration
plus
bloody sheet
*R chest laceration
Hemorrhagic shock from right leg injury
Groaning
↑↑HR
↓↓BP
↑RR
√HemeCon dressing / tourniquet
√Immediate


Laerdal 2
Scenario
Moulage
Simulation
Physiology
Assessment & Intervention
1
*R chest laceration
*R leg laceration
plus
Bloody sheet
*L abdominal abrasion
Hemorrhagic shock from right leg injury
Groaning
↑↑HR
↓↓BP
↑RR
√HemeCon dressing / tourniquet
√Immediate
2
*R chest laceration
*R leg laceration
*L abdominal abrasion
R tension pneumothorax
"I can't breath"
No BS R
↑HR
↓BP
↑↑RR
√R needle decompression
√Immediate
3
*R leg laceration
*R chest laceration
*L abdominal abrasion
Lower airway obstruction
Wheezing
↑↑HR
↓BP
↑↑RR
√Nasal trumpet
√Immediate


Laerdal 3
Scenario
Moulage
Simulation
Physiology
Assessment & Intervention
1
*Bleeding mouth
*R chest laceration
*R abd laceration
Upper airway obstruction
"I can't breathe"
↑↑HR
↔BP
↑↑RR
√Nasal trumpet
√Immediate
2
*Bleeding mouth
*R chest laceration
*R abd laceration
Upper airway obstruction
"I can't breathe"
↑HR
↓BP
↑↑RR
√Nasal trumpet
√Immediate
3
*Bleeding mouth
*R chest laceration
*R abd laceration
Abdominal trauma without shock
"My stomach hurts"
↑HR
↔BP
↔RR
√No intervention
√Delayed


METI
Scenario
Moulage
Simulation
Physiology
Assessment & Intervention
1
*Head laceration
*Left chest laceration
plus
*Bloody sheet under head
Massive head trauma
Blown pupil
↑↑HR
↓↓BP
↑RR
✓Expectant
2
*Head laceration
*Left chest laceration
Chest wound without respiratory distress
↑HR
↔BP
↔RR
✓No intervention
✓Delayed
3
*Head laceration
*Left chest laceration
Left Tension Pneumothorax
No BS L
↑HR
↓BP
↑↑RR
✓L needle de-compression
✓Immediate


SimBaby
Scenario
Moulage
Simulation
Physiology
Assessment & Intervention
1
*Head laceration
*R leg laceration
Minor superficial trauma
Crying
↔ HR
↔ BP
↔ RR
✓No intervention
✓Minimal
2
*Head laceration
*R leg laceration + Bloody Sheet
Hemorrhagic shock from R leg injury
Crying weakly
↑↑HR
↓BP
↑↑RR
✓No intervention
✓Delayed
3
*Head laceration
*R leg laceration
Minor extremity injury
↑HR
↔ BP
↔ RR
✓No intevention
✓Minimal

Appendix C
Manikin Triage Setup

TRIAGE MASTER DOCUMENT

Triage Equipment Bin initially in Debrief room. Collect from student as they complete M scenario, check for contents, place on step stool in SimRoom 1.

		Laerdal 1			
L1A	**R TENSION PNEUMO**	L1B	R leg fx no compromise	L1C	**HEMORRHAGIC SHOCK R leg**
	Blank Triage Form		Blank Triage Form		Blank Triage Form
	R leg laceration / reg pant		R leg laceration / reg pant		R leg laceration / Bloody Pant & Bloody Towel
	R chest laceration / Bloody Shirt & Bloody Towel		R chest laceration / reg shirt		R chest laceration / reg shirt
	"I can't breathe"		*"My leg is broken"*		*"Moaning"*
	Reset sce L1B		Reset sce L1C		Reset sce L1A
	Collect Intervention equipment		Collect Intervention equipment		Collect Intervention equipment
	Collect Completed Triage Form		Collect Completed Triage Form		Collect Completed Triage Form
			Take off bloody sheet & shirt		
	HR 150, B?P 90/50/RR 24 /no BS Right lung		HR 140, B/P 120/80, RR 18		HR 150, B/P 70/30, RR 28
		Laerdal 2			
L2A	**HEMORRHAGIC SHOCK R leg**	**L2B**	**R TENSION PNEUMO**	**L2C**	Lower Airway Obstruc
	Collect Complete Triage Form		Collect Complete Triage Form		Collect Complete Triage Form
	Collect Intervention equipment		Collect Intervention equipment		Collect Intervention equipment
	Set Out Blank Triage Form		Set Out Blank Triage Form		Set Out Blank Triage Form
	R chest laceration + normal shirt		R chest laceration / bloody shirt / bloody towel		R chest laceration / reg shirt
	R leg laceration / Bloody pant / bloody Towel		R leg laceration / reg pant		R leg laceration / reg pant
			Take off bloody sheet, bloody pant		Take off bloody shirt, bloody towel
	L abd abrasion		L abd abrasion		L abd abrasion
	"Groaning" loop		*"I can't breathe" loop*		*"Cough" loop*
	Reset sce L2B		Reset sce L2C		Reset sce L2A
	HR 150, B/P 70/30, RR 28		HR 150, B/P 90/50, RR 24		HR 140, B/P 160/90, RR 28
		Laerdal 3			
L3A	Upper Airway Obstr	**L3B**	Upper Airway Obstr - tongue obstruction	**L3C**	Abd Trauma w/o shock
	Collect Complete Triage Form		Collect Complete Triage Form		Collect Complete Triage Form
	Collect Intervention equipment		Collect Intervention equipment		Collect Intervention equipment
	Set Out Blank Triage Form		Set Out Blank Triage Form		Set Out Blank Triage Form
	Bleeding mouth		Bleeding mouth		Bleeding mouth
	Reg shirt , Reg pant		Reg shirt , Reg pant		Reg shirt , Reg pant
	R abd laceration		R abd laceration		R abd laceration
	"SOB breathing" loop		*No vocal sound*		*"My stomach hurts" loop*
	Reset L3B		Reset sce L3C		Reset sce L3A
	HR 140, B/P 130/80, RR 30		HR 140, B/P 170/90, RR 30		Hr 120, B/P 120/80, RR 16
		Baby			
B1A	Minor Trauma	**B1B**	**HEMORRHAGIC SHOCK R leg**	**B1C**	Minor Trauma
	Collect Complete Triage Form		Collect Complete Triage Form		Collect Complete Triage Form
	Collect Intervention equipment		Collect Intervention equipment		Collect Intervention equipment
	Set Out Blank Triage Form		Set Out Blank Triage Form		Set Out Blank Triage Form
	no clothing		no clothing		no clothing
	Head laceration		Head laceration		Head laceration
	R leg laceration		R leg laceration + Bloody towel		R leg laceration
	"Baby cry" loop		*"weak cry" loop*		*"Baby cry" loop*
	Reset sce: B1B		Reset sce: B1C		Take off bloody towel
					Reset sce: B1A
	HR 120, B/P 94/66		HR 180, 50/20, RR 40		HR 130, B/P 94/66, RR 28
		Laerdal M1A / M1B / M1C			
M1A	**Massive L Head Trauma**	**M1B**	Minor Trauma	**M1C**	**L TENSION PNEUMO**
	Collect Completed Triage Form		Collect Complete Triage Form		Collect Complete Triage Form
	Collect Intervention equipment		Collect Intervention equipment		Collect Intervention equipment
	Set Out Blank Triage Form		Set Out Blank Triage Form		Set Out Blank Triage Form
	Reg shirt , Reg pant		Reg shirt , Reg pant		Reg shirt , Reg pant
	L Head laceration + bloody Towel		L Head laceration NO towel		L Head laceration
	L chest laceration		L chest laceration		L chest laceration + bloody shirt
	L Blown pupil		**Normal pupil**		Normal pupil
	"Moan" loop		*"Something for this pain" loop*		*"I can't breathe" loop*
	HR 150, B/P 70/30, RR 30		HR 90, B/P 120/80, RR 16		HR150, B/P 80/30, RR 40
Iteration Times		Triage Bin Contents			reg = regular or less bloody clothing
9:00 AM	1 hour/student		Needle Decompression		
10:30 AM			NPA		
1:00 PM			Tourniquet		
2:30 PM			HemeCon X 2		
			gauze		
			Pencil		
			Stethoscope		
			B/P cuff		

FLOW			**Notes / Troubleshoot**				
SimRoom 1/2	Setup up scenario/clothes L1, L2, L3 and run scenario. Setup SimBaby but pause it (double check that when it's unpaused, the vocal sounds work)			If no vocalizations - unplug & plug audio cord from computer.			
SimRoom:	Introduction by Dr. Vincent in Debrief Nook in SimRoom 2 or Control Rm. When Student leaves SimRoom 2, start SimBaby A scenario.						
SimRoom	When student completes L3 scenario and leaves SimRoom 1: Enter SimRoom 1 and change to M scenario - clothes/scenario. M Triage Form						
	Collect Completed Triage forms from L1, L2. L3						
	Student complete SimBaby and moves back to SimRoom 2 to complete M scenario						
SimRoom	Collect Baby Triage form, set up next SimBaby scenario						
Hallway	Collect Triage Bin from Student & direct back to Debrief Nook						
SimRoom	Collect M Triage Form and give all to Dr. Vincent						
	Start L1, L2, L3 let run						
	Set out Triage Forms						
SimRoom:	When Debrief done, Start SimBaby and let run						
	SimBaby Triage Form						

Appendix D
SimCenter UH Protocol

Application for New Approval of a Study Involving Human Subjects

University of Hawai‘i, Committee on Human Studies (CHS)
Spalding Hall 253, 2540 Maile Way, Honolulu, Hawai‘i 96822
Telephone: (808) 956-5007

Date: **August 8, 2006**

PI (name & title): **Lawrence Burgess, M.D.** Email: **lburgess@hawaii.edu** Phone: **692.1080**

Department: **Telehealth Research Institute, JABSOM (Dean's Office)**

[X] Faculty or Staff [ ] Student - name of supervising professor: ____________

Training in Human Subject Protection: When, where, & what? ***P.I. Lawrence Burgess*** **- CITI Course in the Protection of Human Research Subjects, Tripler Army Medical Center, on 2/18/2005,** ***Co P.I. Dale Vincent*** **– UH Workshop on The Protection of Human Research Subjects For Research Investigators, on 2/10/2006**

Project Title: **SimCenterHawaii Technology Enabled Learning and Intervention Systems**

Proposed Sponsoring Agency: **United States Army Medical Research and Material Command** Start Date: **1 Oct 2006**

Complete Agency address: **U.S. Army Medical Research Acquisition Activity,**
820 Chandler Street, Fort Detrick, MD 21702-501

1. Summarize your proposed research. Outline objectives and methods.

Simulation technology is a key component to providing new immersive, interactive learning environments and tools. Simulation technology can prove to be a powerful exploration-based learning tool, allowing users to manipulate parameters and visualize results. Simulations can also both aid in grasping difficult concepts, transferring knowledge and can provide readily available cognitive and procedural training platforms that can supplement a didactic curriculum. Two areas in simulation technology are proposed:

1. Medical triage in mass casualty or trauma events is an area where decision-making is vital for achieving positive outcomes. It is necessary that first responders and medical personnel are thoroughly trained and prepared for action; however, there are few opportunities to obtain the training and experience necessary for optimal performance in mass casualty emergency situations. Considering homeland defense needs, there is a large number of personnel that require training. Two simulation training platforms can be applied to triage training and assessment: manikin training and virtual reality (VR) scenarios. Manikin training provides realistic hands-on training, which is particularly geared for students without experience, or for those demonstrating competency for certification. Since VR systems have less hands-on capability, they work well for initial training as a lead into manikin training, or as refresher training for cognitive triage skills.

2. Renal physiology contains many abstract concepts that have been identified to be difficult for students to learn and understand, with the counter-current exchange system ranking number one in basic science difficulty and number two in clinical difficulty. It is postulated that by visualizing these difficult concepts, student learning will be enhanced. The VR Nephron application is a novel application that portrays the difficult concepts in an interactive, 3D environment in which sound and visual are emphasized in acquiring knowledge.

Phase I of this proposal is to determine the effect of simulation training in acquiring triage skills and self-efficacy. Two studies under this phase are proposed, one using manikin simulation and the other using a virtual reality triage application. Phase II includes iterative usability testing for the development VR applications. Two studies are proposed under phase II, testing of a VR triage training scenarios and testing of a virtual nephron teaching application.

Phase I: Simulation Training for Acquisition of Triage Skills – Manikin and Virtual Reality

Objective/Hypotheses: a) Didactic training plus simulation training will result in improved triage skills acquisition over didactic training alone; b) Successive exposure of first responder trainees to a series of three simulation based mass-casualty triage scenarios will result in improvements in triage skills acquisition; c) these same iterative training exposures will result in a measurable change in self-efficacy, and a statistically significant correlation between self-efficacy ratings to actual performance.

Study Design: Learners will acquire triage knowledge through online didactic learning, and then be evaluated on manikins or VR as to how many triage skills were acquired. A second and third assessment will also be accomplished, comparing results of the second and third assessments to the first to determine the effects of sequential simulation training on triage skills acquisition. Self-efficacy and trainee satisfaction questionnaires will be administered after online learning and simulation-based training.

Phase II: Development of Virtual Reality Application – Triage and Nephron
Objective/Hypothesis: Implementing a combination of usability engineering methods, a usability evaluation model that combines two iterations of heuristic usability evaluations and one iteration of user testing, will achieve measurable software design improvements.

Study Design: The graphical models of the avatars and scene, as well as the virtual tools and user interface tools, will be developed with scenarios for the VR Triage and VR Nephron applications. After the initial prototypes of the systems are completed, heuristic usability studies will be conducted to assess the usability of the virtual reality applications. Two iterations of the heuristic evaluation will be conducted, intertwined with software improvements. Lastly, a user evaluation will be conducted to both assesses usability issues and confirm that problems have been fixed during the development process.

2. Summarize all involvement of humans in this project (who, how many, age, sex, length of involvement, frequency, etc.) and the procedures they will be exposed to. Attach survey instrument, if applicable.

Phase I: For each study, manikin and VR, twenty-five medical and allied health students of the University of Hawaii, or professional first responders will be eligible, and will be invited to participate following clearance from their course supervisors.

Procedures:

a) A traditional pre-test and post-test will be utilized to assess didactic knowledge gained through the online curriculum. The trainee must attain a score of greater than 85% to proceed to simulation (manikin or VR) training, with retests allowed up to three times.
b) Determining the effect of simulation training on acquiring triage skills will be accomplished by identifying certain skills to be acquired and then experts will assess each learner in a total of three triage scenarios. Each scenario will have five different injured patients as portrayed by the manikins or virtual patients. The initial assessment scenario following didactic learning will demonstrate the number of skills acquired from didactic learning. The number of skills acquired in each of the following two assessment scenarios will also be measured, and the difference between these sessions and the first session will determine the effect that subsequent simulation training iterations has on skill acquisition.
c) Students will complete two brief questionnaires both three times, after the post-test, after the first simulation scenario is completed and after the final simulation-based training experience.
    1) The *Reaction Questionnaire* is an instrument that has been previously used to assess learner satisfaction with web-based training material (see Appendix C). The questionnaire is designed to assess the relevance of the training to the learner's perceived "role as a first responder" rather than to the learner's usual clinical role.
    2) In measuring the effect on self-efficacy, students will complete the *Learning Environment Questionnaire* (see Appendix D). The total scores of the self-efficacy questionnaires will be analyzed before and after simulation training, and in correlation to the simulation training assessment in part b).

Phase II: For each study, VR Triage and VR Nephron, five usability evaluators that are familiar with virtual environments, with at least one being a usability expert will be used for the heuristic evaluation, and five representative users of the system (i.e. allied health students of the University of Hawaii or professional first responders) will be used for a user evaluation. The participants for the VR Triage study will use a head-mounted computer display that will provide a visual representation of a virtual environment. This display allows one to see computer screen information while blocking out external visual information. The VR Nephron will use a standard PC workstation.

Procedures:

a) The heuristic evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. The VR Triage tasks will coincide with tasks needed to perform the scenarios in Phase I. The VR Nephron will interactively explore the environment and complete educational tasks in the VR environment (i.e. identify anatomy, explore renal physiology concepts). After completion of the application assessment portion, the evaluator will conduct an evaluation based on the *Heuristics for the Virtual Reality Application Evaluation* (see Appendix E). Logged issues will be assigned to the associated heuristic criterion that is violated. Based on defined attributes of usability, evaluators will rank each of the heuristic criterion per stated task on a seven-point Likert scale, where one is *severe* and seven is a violation that is minor or *cosmetic*. Only logged issues where usability is a problem will be graded with this scale.

After completion of the heurisitic evaluation, the overall application will be assessed based on five areas of usability using the *Virtual Reality Target Usability* survey (see Appendix F). Areas of learnability, efficiency, memorability, errors, satisfaction of the overall application will be scored on a seven-point Likert scale, where one is *unacceptable* and seven *exceeds* expectations.

b) The user evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. These tacks will be identical to those in section a). Unlike the heuristic evaluation where users score the application, in the user evaluation our expert faculty and developers will evaluate the users by direct observation in conjunction with videotaping and interviews.

Check whether any subject of your research will be selected from the following categories: NONE

[ ] Minors [ ] Pregnant Women [ ] Mentally Disabled [ ] Fetuses
[ ] Abortuses [ ] Physically Disabled [ ] Prisoners

3. Research involving humans often exposes the subjects to risks: For the purpose of this application, "risk" is defined as exposure of any person to the possibility of injury, including physical, psychological, or social injury, as a consequence of participation as a subject in any research, development, or related activity which departs from the application of those established and accepted methods necessary to meet his needs, or which increases the ordinary risks of daily life, including the recognized risks inherent in a chosen occupation or field or service.

a. Check all the risks to human subjects that apply to your project: NONE

[ ] Physical trauma or pain [ ] Deception [ ] Experimental diagnostic procedures
[ ] Side effects of medications [ ] Loss of privacy [ ] Experimental treatment procedures
[ ] Contraction of disease [ ] Worsening of illness [ ] Other – explain
[ ] Psychological pain [ ] Loss of legal rights

b. Check procedures that will be used to protect human participants from risks: N/A

[ ] M.D. or other appropriately trained individuals in attendance
[ ] Sterile equipment
[ ] Precautions in use of stressor or emotional material (explain below)
[ ] When deception used, subjects fully informed as to nature of research at feasible time (explain below)
[ ] Procedures to minimize changes in self-concept (explain below)
[ ] Confideniality of subjects maintained via code numbers and protected files
[ ] Anonymity - no personally identifiable information collected
[ ] Others-- explain

c. Has provision been made to assure that Human Subjects will be indemnified for expenses incurred as a direct or indirect result of participating in this research?

[ ] Not applicable
[X] No - The following language should appear in the written consent form: ***I understand that if I am injured in the course of this research procedure, I alone may be responsible for the costs of treating my injuries.***
[ ] YES, explain:

d. Are there non-therapeutic tests that the research subjects may be required to pay for?

[ ] Not applicable
[X] No
[ ] Yes - explain below. The following language should appear in the written consent form: ***I understand that I may be responsible for the costs of procedures that are solely part of the research project.***

4. Describe mechanism for safety monitoring: How will you detect if greater harm is accruing to your subjects than you anticipated? What will you do if such increased risk is detected?

The simulation components of this study are currently in use at multiple institutions and facilities and are not considered experimental.

There are minimal to no risks involved in this study. There are no known psychological risks associated with this experiment.

In the virtual reality environment using the head-mounted display (VR Triage), participants may experience mild simulator sickness, which is characterized by temporary nausea, headache, visual disturbances, disorientation, and general discomfort. Individuals susceptible to motion sickness may choose not to participate.

All individuals will be informed that participation is voluntary and that they have the right to refuse to participate in any or all aspects of the study without any negative consequences. Included in consent for the VR Triage participants, an acknowledgment that visual acuity is normal or corrected to normal, and that the participant does not suffer from motion sickness or migraine headaches will be obtained.

Any and all adverse events will be reported to the Committee on Human Studies.

5. Briefly describe the benefits that will accrue to each human subject or to mankind in general, as a result of the individual's participation in this project, so that the committee can access the risk benefit/ratio.

The information gained from the study will help in the education and learning experience of future students and preceptors. This research helps us learn more about the impact and potential benefit of the use of these advanced computing tools for improving the learning experience, as well as provide information on possible need for modification or improvements in these tools.

6. **Participation must be voluntary: the participants cannot waive legal Rights, and must be able to withdraw at any time without prejudice. Indicate how you will obtain informed consent:**

[X] Subject (or Parent/Guardian) reads complete consent form & signs ('written' form)
See Appendix A for Phase I consent, Appendix B for Phase II consent.

[ ] Oral briefings by PI or project personnel, with simple consent form ('oral' form). Explain below the reason(s) why a written consent form is not used

[ ] Other- Explain

7. Are there any other local IRB's reviewing this proposal? [X] No [ ] Yes, Location: ________________________

In addition to the UH IRB, this protocol will be submitted for review and approval to the Human Subjects Research Review Board of the Office of Regulatory Compliance and Quality, U.S. Army Medical Research and Material Command.

I affirm:
(i) that the above and any attachments are a true and accurate statement of the proposed research and of any and all risks to human subjects.

Signed: ____ Date: ________________________
Principal Investigator

Signed: ____ Date: ________________________
Supervising Professor (required if PI is a student)
Date of Human Subject Protection Training: ______________________

Submit the ORIGINAL plus 12 copies of this form with the following attachments:

Three (3) copies of proposal
Thirteen (13) copies of all consent forms
Thirteen (13) copies of any other information to be read or presented to the participants
Thirteen (13) copies of verbal information to be given if short form is used
Thirteen (13) copies of the survey instrument
(Please consult with the CHS staff if providing the survey instrument is a problem.)

APPENDIX A
CONSENT TO PARTICIPATE IN RESEARCH
SIMCENTERHAWAII TECHNOLOGY ENABLED LEARNING AND INTERVENTION SYSTEMS
PHASE I: MANIKIN TRAINING FOR ACQUISITION OF TRIAGE SKILLS

PURPOSE AND BACKGROUND

Lawrence Burgess, M.D., who is the Principal Investigator, from Telehealth Research Institute, John A. Burns School of Medicine, University of Hawaii, is conducting a research study to test the effectiveness of advanced computing tools, including virtual (computer generated) reality, manikin simulation, distance learning technology, and 3 dimensional objects, to see if they can enhance learning for health sciences students, first responders and medical personnel. The study is funded by the U.S. Army Medical Research Acquisition Activity. You are being asked to participate in this research study because you are or have been a health sciences student, professional first responder, a human factors or human-computer interaction expert. These advanced computing tools have been used in other research and teaching settings including in our medical school curriculum, with excellent results thus far. We hope to evaluate and determine the potential value of these methods to enhance the learning experience and the understanding of basic concepts related to associated learning objectives for first responders and medical personnel.

PROCEDURES

If you volunteer to participate in this study, the following things will happen.

Phase I: Simulation Training for Acquisition of Triage Skills

Learners will acquire triage knowledge through online didactic learning, and then be evaluated on manikins or the Virtual Reality (VR) Triage application as to how many triage skills were acquired. A total of 25 participants will be recruited for each study (manikin and VR Triage). The following components will be included in the study:

a) A traditional pre-test and post-test will be utilized to assess didactic knowledge gained through the online curriculum.
b) Determining the effect of simulation training on acquiring triage skills will be accomplished by identifying certain skills to be acquired and then assessing each learner in a total of three triage scenarios. Each scenario will have five different injured patients as portrayed by either manikins or in the VR environment. The initial assessment scenario following didactic learning will demonstrate the number of skills acquired from didactic learning.
c) In measuring the effect on self-efficacy and trainee satisfaction, students will complete a Reaction Questionnaire and Learning Environment Questionnaire, both three times each: before simulation training, after first simulation training scenario, and after the final simulation training experience.

All data that is published will be pooled aggregate data, with no way to match individual test scores to specific test-takers. Participation will take a total of about 2-3 hours over a period of 1 day. All studies involving UH students or preceptors will be conducted at the John A. Burns School of Medicine, University of Hawaii, Kakaako campus.

Experiment Description Phase II:

The application of advanced computer technology with anatomic, physiologic, and pharmacologic realism has increased the applicability to provide advanced simulation training in many areas of acute care medicine. We are studying the use of this technology to help scientists, educators, and engineers to better understand the potential impact on learning. The research design model tests two questions about simulation training in triage: is the addition of simulation training useful as opposed to didactic training alone, and if effective, how many training sessions are necessary?

All trainees will receive simulation training, thus all participants will benefit from the experimental training. In this design, learners serve as their own control as they receive didactic learning followed by simulation-based assessment\training. This study will not look at long-term skills retention, as short-term benefit of simulation training must be demonstrated first.

Prior to the experiment, participants will be oriented to the technology. All learners will have initial web-based didactic training, followed by live didactics. This includes live familiarization with the manikins or VR Triage application. Disease conditions and a set of 29 specific skills to be acquired will be described during didactics, as well as demonstrations of how to perform these actions. A pre- and post-test will be administered prior and after didactic training to determine if didactic knowledge has been acquired. Then sequential manikin or VR assessments will be conducted to determine if such sequential training results in increasing triage skills acquisition. During the experiment, participants will perform examinations of the manikin or VR patients in a simulated environment, in which performance will be evaluated by an expert. Students will complete a trainee satisfaction and self-efficacy questionnaire before starting the simulation training, after first simulation training scenario, and after the final simulation training experience.

After completion of all experimental and test sessions, participants will be given an opportunity to hear feedback regarding aggregate, group-specific test outcome data.

You are able to terminate your participation in the exercise at any time without penalty.

RISKS AND DISCOMFORTS

The simulation components of this study are currently in use at multiple institutions and facilities and are not considered experimental. There are minimal to no risks involved in this study. There are no known psychological risks associated with this experiment.

Due to the time commitments, participation may be caused inconvenience.

If you are participating in the VR Triage study, you may experience mild simulator sickness, due to using the head-mounted display, which is characterized by temporary nausea, headache, visual disturbances, disorientation, and general discomfort. By signing this consent form you acknowledge that your visual acuity is normal or corrected to normal, that you do not suffer from motion sickness or migraine headaches.

By signing this consent form you acknowledge that you have been informed that you can terminate your participation in this study at any time, for any reason and without adverse consequences. Also, that you understand that if you are injured in the course of this research procedure, you alone may be responsible for the costs of treating my injuries.

All information obtained will be kept and your identity will remain anonymous in reports of publications.

BENEFITS

The only benefit in participating in this study is the opportunity to receive experimental manikin or VR triage training. However, it is hoped that the information gained from the study will help in the education and learning experience of future students and preceptors. This research helps us learn more about the impact and potential benefit of the use of these advanced computing tools for improving the learning experience, as well as provide information on possible need for modification or improvements in these tools.

ALTERNATIVES TO PARTICIPATION

The only alternative is to not participate in this study.

CONFIDENTIALITY

Participation in research will involve a loss of privacy, but information about you will be handled as confidentially as possible. Representatives from the U.S. Army Medical Research Acquisition Activity, the University of Hawaii Human Research Review committee that oversees human subject research and the project administrators will have access to your information. Your name will not be used in any published reports about this study.

COSTS OF STUDY

You will not be charged for any of the study procedures.

PAYMENT/COMPENSATION FOR PARTICIPATION

Students participating in the study will not be compensated for their time.

AUTHORIZATION TO OBTAIN/UTILIZE IMAGES

Sometimes an image and/or part of a videotape clearly shows a particular feature or detail that would be helpful in teaching or when presenting the study results at a scientific presentation or in a publication.

By signing this consent form you acknowledge that you are over 18 years of ages and hereby grant permission to the University of Hawaii and its affiliates and subsidiaries to be photographed, and/or videotaped, and to allow the University of Hawaii and its affiliates and subsidiaries to use and/or permit others to use the images or videotapes in which you may appear in for teaching, scientific presentations and/or publications with the understanding that you will not be identified by name. By signing this consent, you acknowledge that you may withdraw this consent at any time without penalty.

NEW FINDINGS

You will be informed of any significant new findings that become available during the course of the study, such as changes in the risks or benefits resulting from participation in the research or new alternatives to participation that might change your mind about participating.

WITHDRAWAL

Your participation in this study is strictly voluntary. You have the right to choose not to participate or to withdraw your participation at any point in this study without prejudice to your future health care, education or other services to which you are otherwise entitled.

QUESTIONS

If you have any questions at any time about the research study, Dr. Burgess or his associates will be glad to answer them at (808) 692-1080 during the hours of 8am - 5pm, Monday through Friday HI time. Or you can write to the following address:

Telehealth Research Institute
John A. Burns School of Medicine
651 Ilalo Street, MEB, Suite 212
Honolulu, HI 96813

If you have questions about your legal rights as a research subject, you may contact:

UH Committee on Human Studies
Phone: (808) 956-5007
2540 Maile Way
Honolulu, Hawaii, 96822.

CONSENT

You will be given a copy of this consent form to keep. By signing this consent form, you are not waiving any of your legal rights, claims, or remedies. If you have questions about your legal rights as a research subject, you may contact the Committee on Human Studies at (808) 956-5007, or write them at 2540 Maile Way, Honolulu, Hawaii, 96822.

I have read (or someone has read to me) the information in this consent form. I have had an opportunity to ask questions and all of my questions have been answered to my satisfaction. By signing this consent form, I willingly agree to participate in this study.

____
Name of Subject (type or print)

Permanent Address:

____
Street

____
City, State, Zip Code

____________________________________ ______________________________
Signature of Subject Date

APPENDIX B
CONSENT TO PARTICIPATE IN RESEARCH
SIMCENTERHAWAII TECHNOLOGY ENABLED LEARNING AND INTERVENTION SYSTEMS
PHASE II: EVALUATION OF THE VIRTUAL REALITY TRIAGE APPLICATION

PURPOSE AND BACKGROUND

Lawrence Burgess, M.D., who is the Principal Investigator, from Telehealth Research Institute, John A. Burns School of Medicine, University of Hawaii, is conducting a research study to test the effectiveness of advanced computing tools, including virtual (computer generated) reality, manikin simulation, distance learning technology, and 3 dimensional objects, to see if they can enhance learning for health sciences students, first responders and medical personnel. The study is funded by the U.S. Army Medical Research Acquisition Activity. You are being asked to participate in this research study because you are or have been a health sciences student, professional first responder, a human factors or human-computer interaction expert. These advanced computing tools have been used in other research and teaching settings including in our medical school curriculum, with excellent results thus far. We hope to evaluate and determine the potential value of these methods to enhance the learning experience and the understanding of basic concepts related to associated learning objectives for first responders and medical personnel.

PROCEDURES

If you volunteer to participate in this study, the following things will happen.

Phase II: Evaluation of the Virtual Reality Applications

You will be either being asked to participate in the Virtual Reality (VR) Triage or VR Nephron application study. Participants will provide feedback as to their potential value, strengths and weaknesses as they relate to the immersive experience. A total of 5 expert evaluators and 5 user evaluators will be recruited for the evaluation of the VR Triage and the evaluation of the VR Nephron studies.

All data that is published will be pooled aggregate data, with no way to match individual test scores to specific test-takers. Participation will take a total of about 2-3 hours over a period of 1 day. All studies involving UH students or preceptors will be conducted at the John A. Burns School of Medicine, University of Hawaii, Kakaako campus.

Experiment Description Phase II:

We are studying the use of virtual reality technology to help scientists, educators, and engineers to better understand their computer software systems and potential impact on learning. The virtual reality environment is a high performance computing, multidimensional virtual laboratory for construction, simulation, evaluation, perception, and comprehension of complex software systems and simulations. This study is testing means of learning in the virtual environment. During the process you will be moving your virtual body around in the three dimensional graphical world. We will be testing various devices, such as motion tracker or mouse/joystick for locomotion, that provide position and velocity input to the graphics computer.

In the VR Triage study, you will be wearing a head-mounted computer display that will provide you with a visual representation of a virtual environment. This display allows you to see computer screen information while blocking out external visual information.

In the VR Nephron study a standard PC workstation will be utilized.

Prior to the experiment, you will be oriented to the technology.

- Heuristic evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. After completion of the application assessment portion, the evaluator will conduct an evaluation. Issues with the application will be logged and assigned to the associated heuristic criterion that is violated. Based on defined attributes of usability, evaluators will rank each of the heuristic criterion task on a seven-point Likert scale, where one is *severe* and seven is a violation that is minor or *cosmetic*. Only logged issues where usability is a problem will be graded with this scale.

  After completion of the heurisitic evaluation, the overall application will be assessed by evaluators based on five areas of usability. Areas of learnability, efficiency, memorability, errors, satisfaction of the overall application will be scored on a seven-point Likert scale, where one is *unacceptable* and seven *exceeds* expectations.

- User evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. Expert faculty and developers will evaluate the users by direct observation in conjunction with videotaping and interviews.

After completion of all experimental sessions, you will be given an opportunity to hear feedback regarding aggregate, group-specific test outcome data.

You are able to terminate your participation in the exercise at any time without penalty.

RISKS AND DISCOMFORTS

The virtual reality components of this study are currently in use at multiple institutions and facilities and are not considered experimental. There are minimal to no risks involved in this study. There are no known psychological risks associated with this experiment. If you are participating in the VR Triage study, you may experience mild simulator sickness, which is characterized by temporary nausea, headache, visual disturbances, disorientation, and general discomfort. Individuals susceptible to motion sickness may choose not to participate. By signing this consent form you acknowledge that my visual acuity is normal or corrected to normal, that you do not suffer from motion sickness or migraine headaches.

Due to the time commitments, participation may cause inconvenience.

Additionally you acknowledge that you have been informed that you can terminate your participation in this study at any time, for any reason and without adverse consequences. Also, you understand that if you are injured in the course of this research procedure, you alone may be responsible for the costs of treating my injuries.

All information obtained will be kept strictly your identity will remain anonymous in reports of publications.

BENEFITS

There will be no direct benefit to you from participating in this study. However, it is hoped that the information gained from the study will help in the education and learning experience of future students and preceptors. This research helps us learn more about the impact and potential benefit of the use of these advanced computing tools for improving the learning experience, as well as provide information on possible need for modification or improvements in these tools.

ALTERNATIVES TO PARTICIPATION

The only alternative is to not participate in this study.

CONFIDENTIALITY

Participation in research will involve a loss of privacy, but information about you will be handled as confidentially as possible. Representatives from the U.S. Army Medical Research Acquisition Activity, the University of Hawaii Human Research Review committee that oversees human subject research and the project administrators will have access to your information. Your name will not be used in any published reports about this study.

COSTS OF STUDY

You will not be charged for any of the study procedures.

PAYMENT/COMPENSATION FOR PARTICIPATION

Students participating in the study will not be compensated for their time.

AUTHORIZATION TO OBTAIN/UTILIZE IMAGES

Sometimes an image and/or part of a videotape clearly shows a particular feature or detail that would be helpful in teaching or when presenting the study results at a scientific presentation or in a publication.

By signing this consent form you acknowledge that you are over 18 years of ages and hereby grant permission to the University of Hawaii and its affiliates and subsidiaries to be photographed, and/or videotaped, and to allow the University of Hawaii and its affiliates and subsidiaries to use and/or permit others to use the images or videotapes in which you may appear in for teaching, scientific presentations and/or publications with the understanding that you will not be identified by name. By signing this consent, you acknowledge that you may withdraw this consent at any time without penalty.

NEW FINDINGS

You will be informed of any significant new findings that become available during the course of the study, such as changes in the risks or benefits resulting from participation in the research or new alternatives to participation that might change your mind about participating.

WITHDRAWAL

Your participation in this study is strictly voluntary. You have the right to choose not to participate or to withdraw your participation at any point in this study without prejudice to your future health care, education or other services to which you are otherwise entitled.

QUESTIONS

If you have any questions at any time about the research study, Dr. Burgess or his associates will be glad to answer them at (808) 692-1080 during the hours of 8am - 5pm, Monday through Friday HI time. Or you can write to the following address:

Telehealth Research Institute
John A. Burns School of Medicine
651 Ilalo Street, MEB, Suite 212
Honolulu, HI 96813

If you have questions about your legal rights as a research subject, you may contact the UH Committee on Human Studies at (808) 956-5007, or write them at 2540 Maile Way, Honolulu, Hawaii, 96822.

CONSENT

You will be given a copy of this consent form to keep. By signing this consent form, you are not waiving any of your legal rights, claims, or remedies. If you have questions about your legal rights as a research subject, you may contact the Committee on Human Studies at (808) 956-5007, or write them at 2540 Maile Way, Honolulu, Hawaii, 96822.

I have read (or someone has read to me) the information in this consent form. I have had an opportunity to ask questions and all of my questions have been answered to my satisfaction. By signing this consent form, I willingly agree to participate in this study.

____
Name of Subject (type or print)

Permanent Address:

____
Street

____
City, State, Zip Code

____________________________________ ______________________________
Signature of Subject Date

Appendix C
Reaction to Triage Module Questionnaire
SimCenterHawaii Technology Enabled Learning and Intervention Systems

In order to determine the effectiveness of this module in meeting your needs and interests, we need your input. Please give us your reactions, and make any comments or suggestions that will help us serve you. Please choose the appropriate response after each statement. Your responses will be used to improve this module.

	Strongly Disagree 1	2	3	4	5	6	***Strongly Agree*** 7
1. The material covered was relevant to my duties as a first responder	1	2	3	4	5	6	7
2. The course objectives were adequately explained.	1	2	3	4	5	6	7
3. The module was well organized.	1	2	3	4	5	6	7
4. The material was presented in an interesting way.	1	2	3	4	5	6	7
5. The module communicated the material effectively.	1	2	3	4	5	6	7
6. As the module progressed, my questions were answered.	1	2	3	4	5	6	7

- -

7. How was the pace of the module?

1	2	3	4	5	6	7
Too slow					***Too fast***	

8. How was the level of difficulty of the module?

1	2	3	4	5	6	7
Too Hard to understand						***Too easy***

13

APPENDIX D
Learning Environment Questionnaire
SimCenterHawaii Technology Enabled Learning and Intervention Systems

Instructions: For each of the items, please rate on a 1 to 4 scale what best describes your response to the item, 1 is Never, 2 is Occasionally, 3 is Frequently and 4 is Always.

1. **I believe I will learn to be an effective first responder.**

1	*2*	*3*	*4*
Never	*Occasionally*	*Frequently*	*Always*

2. **I feel confident that my patients will consider me an effective first responder.**

1	*2*	*3*	*4*
Never	*Occasionally*	*Frequently*	*Always*

3. **I believe my fellow students respect me.**

1	*2*	*3*	*4*
Never	*Occasionally*	*Frequently*	*Always*

4. **I believe that the physician-patient relationship is the most important aspect in triage.**

1	*2*	*3*	*4*
Never	*Occasionally*	*Frequently*	*Always*

5. **I believe that providing emotional support for my patients is as important as physical treatment.**

1	*2*	*3*	*4*
Never	*Occasionally*	*Frequently*	*Always*

APPENDIX E
Heuristics for the Virtual Reality Application Evaluation

Directions: Evaluators will record all problems and errors and categorize them under the relevant usability heuristic listed. After all violations are recorded and categorized, the evaluator will rank the overall violation of the heuristics based on a seven-point Likert scale, where one is *severe* and seven is a violation that is minor or *cosmetic*. If there are no violations for the heuristic, only subjective comments should be given.

1. **Natural engagement.** The interaction in the virtual triage environment should approach the expectation of the user a much as possible. Ideally, the user should not be aware that the virtual environment is not reality.
   Violations: ____
   ____
   ____
   ____
   ____

   Severity of Overall Violations of the Heuristic:

1	2	3	4	5	6	7
Severe						*Cosmetic*

   Comments:____
   ____
   ____
   ____
   ____

2. **Compatibility with the user's task and domain.** The objects in the virtual triage environment (medical tools, office space, furniture, etc…) should correspond as close as possible to the expectation in the real world. This includes their behavior, affordance and task action.
   Violations: ____
   ____
   ____
   ____
   ____

   Severity of Overall Violations of the Heuristic:

1	2	3	4	5	6	7
Severe						*Cosmetic*

Comments:____

3. **Natural expression of action.** The representation of self should allow the user to act and explore in a natural and expected manner and not restrict physical actions. The absence of haptic feedback may hinder this area.
Violations: ____

Severity of Overall Violations of the Heuristic:

1	2	3	4	5	6	7
Severe						*Cosmetic*

Comments:____

4. **Close coordination of action and representation.** The representation of self, behaviors and actions should map to the user's actions. The response time between the user's movements in the real world to that in the virtual world should take less then 200 ms to avoid potential motion sickness.
Violations: ____

____
____

Severity of Overall Violations of the Heuristic:

1 2 3 4 5 6 7

Severe *Cosmetic*

Comments:____
____
____
____
____

5. **Realistic feedback.** The effect of the user's actions on virtual objects should be immediately and conform to the user's perceptions, expectations and laws of physics.
Violations: ____
____
____
____
____

Severity of Overall Violations of the Heuristic:

1 2 3 4 5 6 7

Severe *Cosmetic*

Comments:____
____
____
____
____

6. **Faithful viewpoints.** The visual representation of the triage virtual environment should map to the user's normal perception. Head movement and viewpoint changes should be rendered

without delay.
Violations: ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

7. **Navigation and orientation support.** The user should always be able to orient themselves in the virtual environment and be able to return to known, present positions.
Violations: ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

8. **Clear entry and exit points.** How to enter and exit the virtual environment should be clearly communicated.
Violations: ____

____

____

____

____

Severity of Overall Violations of the Heuristic:

1	2	3	4	5	6	7
Severe						*Cosmetic*

Comments:____

____

____

____

____

9. **Consistent departures.** Design compromises or substitutions in the virtual environment should be consistent and clearly marked or communicated.
Violations: ____

____

____

____

____

Severity of Overall Violations of the Heuristic:

1	2	3	4	5	6	7
Severe						*Cosmetic*

Comments:____

____

____

____

____

10. **Support for learning.** Active objects should have cues and, if necessary, have some sort of explanation of their purpose in the virtual environment.
Violations: ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

11. Clear turn-taking. When the system initiates control of the environment, it should be clearly signaled and conventions should be established.
Violations: ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

12. **Sense of Presence.** The user's sense of present "being there" in the virtual world should be as natural as possible.
Violations: ____
____
____
____
____

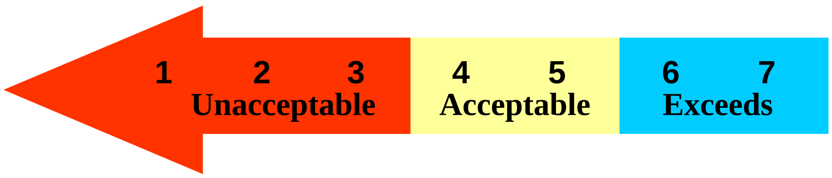
Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____
____
____
____
____

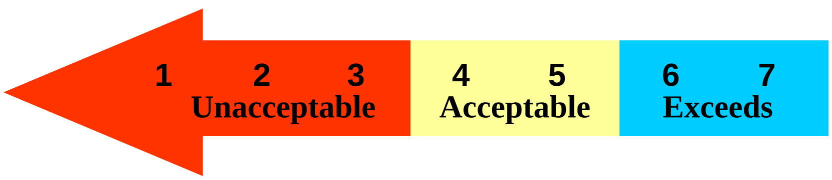
APPENDIX F
Virtual Reality Target Usability

Instructions: For each of the items, please rate on a 1 to 7 scale where 1 – 3 is an *unacceptable* level (1 being worse than 3), 4-5 is an *acceptable* level (4 being less acceptable than 5), and 6-7 *exceeds* expectations (6 being less exceeds than 7).

- ***Learnability***: the system should be easy to learn, so that the user can rapidly start performing tasks in the environment.



- ***Efficiency***: The system should be efficient to use, once the user has learned how to use the virtual triage, objectives should be able to be accomplished similar to that of the real world.



- ***Memorability***: The system should be easy to remember, so that a user may return to the virtual triage environment without having to learn again how to use the interface.

- ***Errors***: The system should have a low rate of interface errors (i.e. errors trying to navigate, errors trying to apply tools, etc…), and if errors occur, users should be able to easily recover from them. Catastrophic error must not occur.

- ***Satisfaction***: The system should be pleasant to use, users must be satisfied and like using the system.

UNIVERSITY OF HAWAI'I

Committee on Human Studies

MEMORANDUM

August 25, 2006

TO: Lawrence Burgess, M.D.
Principal Investigator
Telehealth Research Institute

FROM: William H. Dendle
Executive Secretary

SUBJECT: CHS #14638- "SimCenterHawaii Technology Enabled Learning and Intervention Systems"

Your project identified above was reviewed by the Chair of the Committee on Human Studies through Expedited Review procedures. The project qualifies for expedited review by CFR 46.110 and 21 CFR 56.110, Category (4,7) of the DHHS list of expedited review categories.

This project was approved on August 25, 2006 for one year. If in the active development of your project you intend to change the involvement of humans from plans indicated in the materials presented for review, prior approval must be received from the CHS before proceeding. If unanticipated problems arise involving the risks to subjects or others, report must be made promptly to the CHS, either to its Chairperson or to this office. This is required in order that (1) updating of protective measures for humans involved may be accomplished, and (2) prompt report to DHHS and FDA may be made by the University if required.

In accordance with the University policy, you are expected to maintain, as an essential part of your project records, all records pertaining to the involvement of humans in this project, including any summaries of information conveyed, data, complaints, correspondence, and any executed forms. These records must be retained for at least three years from the expiration/termination date of this study.

The CHS approval period for this project will expire on August 25, 2007. If your project continues beyond this date, you must submit a continuation application to the CHS at least four weeks prior to the expiration of this study.

We wish you success in this endeavor and are ready to assist you and your project personnel at any time.

Enclosed is your certification for this project.

Enclosures

2540 Maile Way, Spalding 252, Honolulu, Hawai'i 96822-2303
Telephone: (808) 539-3955/(808) 956-5007, Facsimile: (808) 539-3954, Web site: www.hawaii.edu/irb

UNIVERSITY OF HAWAI'I

Committee on Human Studies

August 25, 2006

U.S. Army Medical Research Acquisition Activity
820 Chandler Street
Fort Detrick, MD 21702

Dear Madam/Sir:

This refers to an application entitled "SimCenterHawaii Technology Enabled Learning and Intervention Systems," by Dr. Lawrence Burgess, principal investigator.

This application has been reviewed and approved for one year by the University of Hawaii institutional review board, the Committee on Human Studies. Enclosed is our certificate for this project.

Sincerely yours,

William H. Dendle
Compliance Officer

Enclosure

c: Dr. Lawrence Burgess
CHS #14638

2540 Maile Way, Spalding 252, Honolulu, Hawai'i 96822-2303
Telephone: (808) 539-3955/(808) 956-5007, Facsimile: (808) 539-3954, Web site: www.hawaii.edu/irb

Protection of Human Subjects
Assurance Identification/IRB Certification/Declaration of Exemption
(Common Rule)

Policy: Research activities involving human subjects may not be conducted or supported by the Departments and Agencies adopting the Common Rule (56FR28003, June 18, 1991) unless the activities are exempt from or approved in accordance with the Common Rule. See section 101(b) of the Common Rule for exemptions. Institutions submitting applications or proposals for support must submit certification of appropriate Institutional Review Board (IRB) review and approval to the Department or Agency in accordance with the Common Rule.

Institutions must have an assurance of compliance that applies to the research to be conducted and should submit certification of IRB review and approval with each application or proposal unless otherwise advised by the Department or Agency.

1. Request Type	2. Type of Mechanism	3. Name of Federal Department or Agency and, if known, Application or Proposal Identification No.
[X] ORIGINAL [ ] CONTINUATION [ ] EXEMPTION	[X] GRANT [ ] CONTRACT [ ] FELLOWSHIP [ ] COOPERATIVE AGREEMENT [ ] OTHER:______	U.S. Army Medical Research

4. Title of Application or Activity	5. Name of Principal Investigator, Program Director, Fellow, or Other
"SimCenterHawaii Technology Enabled Learning and Intervention Systems"	Lawrence Burgess, M.D.

6. Assurance Status of this Project *(Respond to one of the following)*

[X] This Assurance, on file with Department of Health and Human Services, covers this activity:
Assurance Identification No. F-3526 , the expiration date September 23, 2008 IRB Registration No. IORG0000169

[ ] This Assurance, on file with *(agency/dept)*______, covers this activity.
Assurance No.______, the expiration date______ IRB Registration/Identification No.______ *(if applicable)*

[ ] No assurance has been filed for this institution. This institution declares that it will provide an Assurance and Certification of IRB review and approval upon request.

[ ] Exemption Status: Human subjects are involved, but this activity qualifies for exemption under Section 101(b), paragraph______.

7. Certification of IRB Review (Respond to one of the following IF you have an Assurance on file)

[X] This activity has been reviewed and approved by the IRB in accordance with the Common Rule and any other governing regulations.
by: [ ] Full IRB Review on (date of IRB meeting) ______ or [X] Expedited Review on August 25, 2006
[ ] If less than one year approval, provide expiration date ______

[ ] This activity contains multiple projects, some of which have not been reviewed. The IRB has granted approval on condition that all projects covered by the Common Rule will be reviewed and approved before they are initiated and that appropriate further certification will be submitted.

8. Comments

CHS #14638

9. The official signing below certifies that the information provided above is correct and that, as required, future reviews will be performed until study closure and certification will be provided.	10. Name and Address of Institution University of Hawaii at Manoa 2444 Dole Street, Bachman Hall Honolulu, HI 96822
11. Phone No. *(with area code)* (808) 956-5007 12. Fax No. *(with area code)* (808) 539-3954 13. Email: dendle@hawaii.edu	
14. Name of Official William H. Dendle	15. Title Compliance Officer
16. Signature [signature]	17. Date August 25, 2006

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Appendix E
SimCenter Army Protocol

January 25, 2007

MEMORANDUM

TO: United States Army Medical Research and Material Command Office of Research Protections

ATTN: Kimberly L. Odam, MS, CCRP
Human Subjects Protection Scientist (AMDEX Corp.)

FROM: Lawrence Burgess, M.D., Principal Investigator

SUBJECT: SimCenterHawaii Technology Enabled Learning and Intervention Systems Protocol

The following is a modified submission of the protocol, "SimCenterHawaii Technology Enabled Learning and Intervention Systems," submitted by Lawrence P. Burgess M.D., Telehealth Research Institute, Honolulu, HI. Proposal Log Number 06083002, Award Number Pending, HRPO Log Number A-14006.

This protocol has been modified according to the requests and recommendations of the Memorandum for Record, MCMR-ZB-PH (70-1n1), dated 20 October, 2006 (modifications are in blue text)

In addition, we are requesting additional modifications as follows.

We have modified the self-efficacy instrument to a 5 point Likert scale. Also, to better address issues of self-efficacy, three additional items that address self-perception of performance in mass casualty situations (questions 3,4,5) have been added (see Appendix E, modifications highlighted in yellow).

Due to logistical difficulties in recruitment for Phase I of the study protocol, we have modified the protocol to expand our source of subject participates to include any allied health student or recent health related graduates residing in Hawaii (not just from the University of Hawaii system) (modifications highlighted in yellow). A recruitment flyer has also been added (see Appendix A).

We would also like to offer compensation as follows (modifications highlighted in yellow):

- $50 retail gift certificates for volunteer participants in Phase I, Simulation Training for Acquisition of Triage Skills
- $25 retail gift certificates for volunteer participants in Phase II "user" evaluations
- $250 honorarium for volunteer participants in Phase II "expert" heuristic evaluations

Protocol and consent forms have been modified to reflect the requested changes.

Lawrence Burgess, M.D
Principal Investigator

SimCenterHawaii Technology Enabled Learning and Intervention Systems

PI: Lawrence P. Burgess, M.D.
Telehealth Research Institute
John A. Burns School of Medicine
University of Hawaii
651 Ilalo Street, MEB, Honolulu, HI 96813

Human Use Protocol Submitted to:

United States Army Medical Research and Material Command Office of Research Protections
(USAMRMC ORP)
Fort Detrick, MD

Date: 25 January 2007

TABLE OF CONTENT

APPLICATION FOR
CLINICAL INVESTIGATION PROJECT INVOLVING HUMAN SUBJECTS

1. **PROTOCOL INFORMATION**:
   Title: SimCenterHawaii Technology Enabled Learning and Intervention Systems
   Proposal No: 06083002
   Version/Date of Protocol: 2006

2. **PRINCIPAL INVESTIGATOR**:
   Lawrence Burgess, MD
   Director, Telehealth Research Institute
   University of Hawaii John A Burns School of Medicine
   e-mail: lburgess@hawaii.edu
   Tel: (808) 692-1080
   Fax: (808 692-1250
   Telehealth Research Institute
   University of Hawaii
   John A. Burns School of Medicine
   651 Ilalo Street; Honolulu, HI 96813-5534

3. **OTHER KEY PERSONNEL**

Name(s)	Title	Role	Effort (%)
Dale Vincent, M.D.	Director of Telemedicine	Co-Investigator	30%
Benjamin Berg, M.D	Faculty, JABSOM	Senior Faculty	5%
Andrei Sherstyuk, Ph.D.	Dir. Software Development	Software development, Technical lead	50%
Kathleen Kihmm, M.S.	Program Manger	Project Manager, Research Assistant	50%

See *16. Roles and Responsibilities* for description of effort

4. **LOCATION OF STUDY:**
   Telehealth Research Institute
   University of Hawaii
   John A. Burns School of Medicine
   651 Ilalo Street; Honolulu, HI 96813-5534

5. **TIME REQUIRED TO COMPLETE THE STUDY:**
   24 Months

6. INTRODUCTION:

a. SYNOPSIS:

Simulation technology is a key component to providing new immersive, interactive learning environments and tools. Simulation technology can prove to be a powerful exploration-based learning tool, allowing users to manipulate parameters and visualize results. Simulations can also both aid in grasping difficult concepts, transferring knowledge and can provide readily available cognitive and procedural training platforms that can supplement a didactic curriculum. Two areas in simulation technology are proposed:

1. Medical triage in mass casualty or trauma events is an area where decision-making is vital for achieving positive outcomes. It is necessary that first responders and medical personnel are thoroughly trained and prepared for action; however, there are few opportunities to obtain the training and experience necessary for optimal performance in mass casualty emergency situations. Considering homeland defense needs, there is a large number of personnel that require training. Two simulation training platforms can be applied to triage training and assessment: manikin training and virtual reality (VR) scenarios. Manikin training provides realistic hands-on training, which is particularly geared for students without experience, or for those demonstrating competency for certification. Since VR systems have less hands-on capability, they work well for initial training as a lead into manikin training, or as refresher training for cognitive triage skills.

2. Renal physiology contains many abstract concepts that have been identified to be difficult for students to learn and understand, with the counter-current exchange system ranking number one in basic science difficulty and number two in clinical difficulty. It is postulated that by visualizing these difficult concepts, student learning will be enhanced. The VR Nephron application is a novel application that portrays the difficult concepts in an interactive, 3D environment in which sound and visual are emphasized in acquiring knowledge.

Phase I of this proposal is to determine the effect of simulation training in acquiring triage skills and self-efficacy. Two studies under this phase are proposed, one using manikin simulation and the other using a virtual reality triage application (separate subjects). Phase II includes iterative usability testing for the development VR applications. Two studies are proposed under phase II, testing of a VR triage training scenarios and testing of a virtual nephron teaching application.

1. <u>Phase I: Simulation Training for Acquisition of Triage Skills -- Manikin and Virtual Reality</u>

Objective/Hypotheses: a) Didactic training plus simulation training will result in improved triage skills acquisition over didactic training alone; b) Successive exposure of first responder trainees to a series of three simulation based mass-casualty triage scenarios will result in improvements in triage skills acquisition; c) these same iterative training exposures will result in a measurable change in self-efficacy, and a statistically significant correlation between self-efficacy ratings to actual performance.

Study Design: Two studies will be conducted, one using manikins as the simulation intervention, the other using virtual reality as the simulation intervention. Learners will first acquire triage knowledge through online didactic learning, and then be evaluated on manikins or VR as to how many triage skills were acquired. A second and third assessment will also be accomplished, comparing results of the second and third assessments to the first to determine the effects of sequential simulation training on triage skills acquisition. Self-efficacy and trainee satisfaction questionnaires will be administered after online learning and simulation-based training.

Technical Objectives:

- *Task 1. Develop online triage course*
  Development of the online triage course will first consist of content development. This includes reviewing and compiling existing published triage standards. Subject matter experts will decided on the appropriate curricular material and integrate into the manikin and VR curriculum. The technical team will develop a website where the curriculum will be posted. All questionnaires and surveys will be available on the website. A database will be established so all results will be collected and stored. As the website development progresses, subject matter experts and will review for content and usability. Iterative enhancements will be conducted so the website optimizes functionality and usability.
- *Task 2. Program manikins and VR triage*
  Manikins and VR triage will be programmed according to curriculum specifications.
- *Task 3. Conduct all appropriate procedures with institutional review boards*
  The University of Hawaii, John A. Burns School of Medicine intends to comply with all federal and DoD regulations regarding the protection of human subjects.
- *Task 4. Conduct acquisition of triage skills study*
  We hypothesize that a simulation intervention (VR or manikin training) will improve triage skills acquisition and performance. Medical and allied health students or recent graduates will be recruited to complete the online curriculum, with a pre- and post-test administered to determine if didactic knowledge has been acquired. Sequential manikin or VR assessments will be conducted to determine if such sequential training results in increasing triage skills acquisition, and how many iterations are required.
- *Task 5. Skills acquisition relative to self-efficacy study*
  We hypothesize that the same VR or manikin training in Task 4 will result in a statistically significant change in self-efficacy, and a statistically significant correlation between self-efficacy ratings to actual performance. Participants will complete a self-efficacy questionnaire before VR or manikin training, after first VR or manikin training scenario, and after the final VR or manikin training

experience. The results will be analyzed to assess the impact of the manikin experience on student perception of the learning environment.

- *Task 6. Analyze data and publish results*

  At the completion of the study, the data will be compiled and analyzed using the appropriate statistical procedures. A report on the findings will be written and published.

2. <u>Phase II: Development of Virtual Reality Applications – Triage and Nephron</u>

Objective/Hypothesis: Implementing a combination of usability engineering methods, a usability evaluation model that combines two iterations of heuristic usability evaluations and one iteration of user testing, will achieve measurable software design improvements.

Study Design: Two studies are proposed under this phase, one evaluating the virtual reality triage application, the other evaluating the virtual reality nephron application. The graphical models of the avatars and scene, as well as the virtual tools and user interface tools, will be developed with scenarios for the VR Triage and VR Nephron applications. After the initial prototypes of the systems are completed, heuristic usability studies will be conducted to assess the usability of the virtual reality applications. Two iterations of the heuristic evaluation will be conducted, intertwined with software improvements. Lastly, a user evaluation will be conducted to both assesses usability issues and confirm that problems have been fixed during the development process.

Technical Objectives:

- *Task 1. Develop virtual reality application*

  The University of Hawaii, John A. Burns School of Medicine has been conducting multidisciplinary research and development in areas of emerging technologies and virtual reality over the last five years. In collaboration with University of New Mexico, a virtual reality subdural hematoma application and a virtual reality renal physiology application have previously been developed. For this proposal, we plan to

  1. Develop the graphical models of the avatars and scene, as well as the virtual tools needed for conducting triage. Locomotion metaphors (how the user will move around in the virtual environment) will be developed and tested. The application will be developed to consist of three different scenarios with five patients each. The scenarios will be designed to mimic the learning objectives and methodology specified in the manikin curriculum, such that with future funding the Phase I manikin study can be replicated with the virtual patients in place of the manikin patients.
  2. Develop and integrate gaming components to the prototype. This includes an interactive user interface, appropriate feedback, scoring capability and levels of difficulty. This will allow users to interact with the system with an intended educational goal.

Feedback from experts and non-experts will be received to ensure a user-centered design.

- *Task 2. Conduct all appropriate procedures with institutional review boards*
  The University of Hawaii, John A. Burns School of Medicine intends to comply with all federal and DoD regulations regarding the protection of human subjects.
- *Task 3. Conduct usability study and publish results*
  We hypothesize that using a usability evaluation model that combines two iterations of heuristic usability evaluations and one iteration of user testing will achieve measurable software design improvements. Heuristic usability studies will be conducted to assess the usability of both the nephron and triage virtual reality applications. Two iterations of the heuristic evaluation on each application will be conducted, intertwined with software improvements. Lastly, a user evaluation will be conducted to both assesses usability issues and confirm problems fixed. Usability testing is separate and distinguishable from the evaluation of learning and educational value. Results will be published. This will be repeated, if necessary to attain at least *minimum acceptable* levels of usability based on the target usability survey.

b. MEDICAL APPLICATION:

Simulation technology is a key component to providing new immersive, interactive learning environments and tools. Simulation technology can prove to be a powerful exploration-based learning tool, allowing users to manipulate parameters and visualize results. Research has shown that simulation and immersive environments enhance learning by the having the ability to make complex principals more concrete and facilitates learning by doing. Simulations can both aid in grasping difficult concepts, transferring knowledge and can provide readily available cognitive and procedural training platforms that can supplement a didactic triage curriculum. The two phases address different aspects of simulation technology:

- Simulation technology can provide a solution for the need to train triage by providing readily available cognitive and procedural training platforms that can supplement a didactic triage curriculum. In addition to skills training, simulation exercises can help lower psychological barriers in stressful emergency situations by providing a safe controlled environment for practice. Similar to the value of flight simulators for pilots, medical simulators permit both physical and mental skills development and maintenance for health care providers. Another advantage of simulation is the availability for longitudinal training. It has been shown that learned skills, such as cardiopulmonary resuscitation (CPR) can deteriorate as early as two weeks after training, both in lay persons and in medical personnel, with skills equaling pre-assessment baseline at 6-months for physicians and nurses. Thus, frequent retraining is essential for infrequently performed procedures like CPR. Simulation training can provide an opportunity to train and retrain so skills can be maintained.
- Renal physiology is a complex and key subject in medical education. The kidneys are vital in maintaining internal homeostasis, which includes maintaining

total body water, and balancing electrolytes (such as potassium or sodium) and non-electrolytes (such as glucose). In addition, one of the most commonly prescribed medications worldwide is Diuretics. This medication is commonly used for conditions such as hypertension, nephritic syndrome, hypercalciuric renal lithiases, diabetes insipidus, cerebral edema and glaucoma. Normal or compensated renal function is fundamental in maintaining human health; thus it is both important to understand the physiology and pathophsiology of renal diseases, as well as the effects of pharmacology on the renal system. We propose a VR application that uses a novel gaming concept to portray difficult concepts in an interactive, 3D setting in which sound and visual imagery are leveraged to engage and motivate learners.

c. OBJECTIVES:

This protocol has two overall objectives:

Phase I: A triage curriculum will be developed that includes online course material and simulation training, which includes virtual reality and manikin training. Of objective of this phase is to demonstrate the following: a) didactic training plus simulation training will result in improved triage skills acquisition over didactic training alone; b) Successive exposure of first responder trainees to a series of three simulation based mass-casualty triage scenarios will result in improvements in triage skills acquisition; c) these same iterative training exposures will result in a measurable change in self-efficacy, and a statistically significant correlation between self-efficacy ratings to actual performance.

Phase II: A virtual reality application can enhance education and learning. This phase will focus on the development of the virtual reality applications only; educational impact will not be evaluated in this protocol. The objective of this phase is to implement a combination of usability engineering methods, a usability evaluation model that combines two iterations of heuristic usability evaluations and one iteration of user testing, will achieve measurable software design improvements.

d. BIBLIOGRAPHY

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7. RESEARCH PLAN:

a. Phase I: Simulation Training for Acquisition of Triage Skills -- Manikin and Virtual Reality

1. Participant Population: A convenience sample of twenty-five medical and allied health students or recent graduates will be eligible, and will be invited to participate following clearance from their course supervisors (if applicable). For the purpose of validating the manikin and VR triage curriculum utilizing a relatively inexperienced group of learners will maximize the likelihood to measure a change in the acquisition of triage skills from didactics through the three sets of five casualties. Also, healthcare students have the potential to constitute a significant pool of first responders in an emergency situation for homeland defense purposes.

2. Number of Subjects: A convenience sample of twenty-five medical and allied health students or recent graduates will be eligible, and will be invited to participate following clearance from their course supervisors.

3. Recruitment process: The PIs will directly recruit medical school or allied health students or recent graduates that are enrolled in healthcare related courses or have recently graduated with a health related degree. Flyers will be used to recruit participants (see Appendix A). Any student enrolled as a medical student or allied health student or recent graduate will be eligible to participate. The following will be guidelines: participation will be voluntary; individual performance results will be anonymized; and only aggregated group results will be made available to non-Telehealth Research Institute faculty.

4. Procedures:

a) Informed consent will be solicited and must be agreed upon and signed in order to participate (see *Appendix B* for consent form).
b) Since participants will act as their own control in assessing knowledge gained, all participants will be participate in the manikin training and assessment procedures.

c) A traditional pre-test and post-test will be utilized to assess didactic knowledge gained through the online curriculum. Both pre-test and post-test will consist of traditional multiple choice and true-false questions. The trainee must attain a score of greater than 85% to proceed to simulation training, with retests allowed up to three times.

d) Determining the effect of simulation training on acquiring triage skills will be accomplished by identifying certain skills to be acquired and then experts will assess each learner in a total of three triage scenarios. Each scenario will have five different injured patients portrayed by the manikins or virtual models. The initial assessment scenario following didactic learning will demonstrate the number of skills acquired from didactic learning. The number of skills acquired in each of the following two assessment scenarios will also be measured, and the difference between these sessions and the first session will determine the effect that subsequent simulation training iterations has on skill acquisition.

e) Participants will complete two brief questionnaires both three times, after the post-test, after the first simulation scenario is completed and after the final simulation training experience.

    1) The *Reaction Questionnaire*, a previously published instrument (Pololi, 2000), has been previously used to assess learner satisfaction with web-based training material (see *Appendix D*). The questionnaire is designed to assess the relevance of the training to the learner's perceived "role as a first responder" rather than to the learner's usual clinical role.

    2) In measuring the effect on self-efficacy, students will complete the *Learning Environment Questionnaire* (see *Appendix E*). The total scores of the self-efficacy questionnaires will be analyzed before and after simulation training, and in correlation to the manikin training assessment in part b).

f) Study will last a total of approximately two hours.

g) All participants will receive a $50 retail gift certificate for participating in this study.

5. *Data Analysis:*

a) For the hypothesis that successive exposure of first responder trainees to a series of mass casualty triage scenarios using simulation will result in improvements in triage skills acquisition, the analysis is designed as a repeated measures analysis of task completion of triage skills (yes or no) between Scenarios 1, 2, and 3. Cochran's Q will be used for analysis, which is a nonparametric equivalent of a one-sample repeated measures design for dichotomous variables.

Analysis of results of the online curriculum will also be conducted, using a one-way repeated measures model with multiple levels, i.e., modules. Outcome measures include pre- and post-training tests of knowledge and trainee satisfaction ratings. A paired t test will be used to compare pre- and post-training tests. The value of the online didactic curriculum in attaining the desired educational goals will be assessed.

b) For the hypothesis that iterative training exposures will result in a measurable change in self-efficacy, and a measurable positive correlation between self-efficacy ratings to actual performance, the LEQ scores will be analyzed. The overall score for each

LEQ scale will be presented as the total score of the items in the scale. Higher scores will indicate more positive answers. Overall scores for each student will be compared using one-way repeated measures model: before manikin training, after the first training and after the manikin training is completed. Pearson's correlation between the overall LEQ scores and performance of triage skills (scenarios 1, and 3) will be analyzed.

b. Phase II: Development of Virtual Reality Applications – Triage and Nephron

1. *Participant Population*: A convenience sample of five usability evaluators that are familiar with virtual environments, with at least one being a usability expert will be used for the heuristic evaluation of the Virtual Reality applications. These participates will be faculty or research staff that has considerable experience in the areas of human-computer interaction and/or human factors. A convenience sample of five representative users of the system (i.e. allied health students of the University of Hawaii or professional first responders) will be used for a user evaluation. These participants represent potential users of the application.

2. *Number of Subjects:* A convenience sample of five usability evaluators that are familiar with virtual environments, with at least one being a usability expert, will be used for the heuristic evaluation for the initial two evaluations. A convenience sample of five first-responders (users) will be used for the user evaluation portion.

3. *Recruitment process:* Faculty and staff from the University of Hawaii Information and Computer Sciences department, as well as the Telehealth Research Institute will be contacted by the project's PIs and asked to participate. Five first responders, who are affiliated with the University of Hawaii, will be contacted by referral from University of Hawaii faculty or staff.

4. *Procedures*:
   a) Informed consent will be solicited and must be agreed upon and signed in order to participate (see *Appendix C* for consent form).
   b) All five participants will participate in all aspects of the study.
   c) The heuristic evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. These tasks will coincide with tasks needed to perform the scenarios in Phase I for the triage project, and will be determined for the virtual nephron project. After completion of the application assessment portion, the evaluator will conduct an evaluation based on the *Heuristics for the Virtual Reality Triage Application Evaluation* (see *Appendix F,* Sutcliffe, 2004). Logged issues will be assigned to the associated heuristic criterion that is violated. Based on defined attributes of usability, evaluators will rank each of the heuristic criterion per stated task on a seven-point Likert scale, where one is *severe* and seven is a violation that is minor or *cosmetic*. Only logged issues where usability is a problem will be graded with this scale.

   After completion of the heurisitic evaluation, the overall application will be assessed based on five areas of usability using the *Virtual Reality Target Usability* survey (see *Appendix G*, Neilsen, 1993). Areas of learnability, efficiency, memorability, errors, satisfaction of the overall application will be scored on a seven-point Likert scale, where one is *unacceptable* and seven *exceeds* expectations.

d) Heuristic evaluators will receive a $250 honorarium for participating in this study

e) The user evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. These tasks will coincide with tasks needed to perform the scenarios in Phase I. Unlike the heuristic evaluation where users score the application, in the user evaluation our expert faculty and developers will evaluate the users by direct observation in conjunction with videotaping and interviews.

f) User evaluators will receive a $25 retail gift certificate for participating in this study.

5. *Data Analysis:* This is not an experimental study where statistically significant results are desired, and sample size determination is not applicable. The usability evaluation (heuristic and user) is a development model to ensure that a system is designed and developed with usability in mind. The ratings and problem list will be the basis for prioritizing the modifications of the software. Scores should increase to minimum acceptable levels and these should mirror subjective comments.

Descriptive statistics can be utilized to review these results. A chi-square analysis will be used to analyze results between the heuristic evaluators and between the two heuristic evaluations. Also, the frequencies of the sum of logged usability issues and number of heuristic violations will be assessed for each evaluation to determine if improvements on the user interface demonstrated any effect. Lastly, the results of heuristic evaluations will be compared to the user's task performance to determine the impact of the issues identified by the heuristic evaluation.

Once the application meets the minimum acceptable standards for usability through this process, a full evaluation of the application can be conducted. Therefore, the process may need to be repeated until usability is acceptable. Minimum acceptable standards are defined as scores of ≥ 4 in combination with acceptable subjective comments.

c. INCLUSION CRITERIA:

All participants must by 18 years of age or older, English speaking and must agree to sign the consent form.

Pregnant subjects will not be excluded from participation in the study.

d. EXCLUSION CRITERIA:

If participating in the VR Triage study, participants may experience mild simulator sickness, due to using the head-mounted display, which is characterized by temporary nausea, headache, visual disturbances, disorientation, and general discomfort. The following participants will not be asked to participate in the study:

(1) Participants with visual acuity that is not normal or not corrected to normal (visual acuity is defined as vision that is assessed to be eligible for driving a motor vehicle)
(2) Participants who suffer from motion sickness
(3) Participants who suffer from migraine headaches

e. SOURCE OF SUBJECTS:

- Local Hawaii colleges, universities and health related training facilities
- Local Honolulu, HI professional first responders

f. SUBJECT IDENTIFICATION:

Representatives from the U.S. Army Medical Research and Material Command (USAMRMC), and the University of Hawaii Human Research Review committee that oversees human subject research and the project administrators will have access to identifiable participant information. Identifiable information will not be used in any published reports about this study, nor will be given out to anyone outside the project administration, USAMRMC or UH Human Research Review. Accurate and complete study records will be maintained and made available to representatives of the U.S. Army Medical Research and Materiel Command as a part of their responsibility to protect human subjects in research. Research records will be stored in a manner so as to protect the confidentiality of subject information. In addition, all data that is published will be pooled aggregate data, with no way to match individual results to specific participants.

g. SUBJECT ASSESSMENT:

a. Phase I: Simulation Training for Acquisition of Triage Skills

Learners will acquire triage knowledge through online didactic learning, and then be evaluated on either manikins or in the virtual reality triage application, depending on which study group they are involved in, as to how many triage skills were acquired. The following components will be included in the study:

a) A traditional pre-test and post-test will be utilized to assess didactic knowledge gained through the online curriculum.
b) Determining the effect of simulation training on acquiring triage skills will be accomplished by identifying certain skills to be acquired and then assessing each learner in a total of three triage scenarios. Each scenario will have five different injured patients as portrayed by the simulation (manikin or virtual reality). The initial assessment scenario following didactic learning will demonstrate the number of skills acquired from didactic learning.
c) In measuring the effect on self-efficacy and trainee satisfaction, students will complete a Reaction Questionnaire and Learning Environment Questionnaire, both three times each: before simulation training, after first simulation training scenario, and after the final simulation training experience.

b. Phase II: Development of Virtual Reality Triage Application

<u>Heuristic evaluators</u> will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. After completion of

the application assessment portion, the evaluator will conduct an evaluation. Issues with the application will be logged and assigned to the associated heuristic criterion that is violated. Based on defined attributes of usability, evaluators will rank each of the heuristic criterion task on a seven-point Likert scale, where one is *severe* and seven is a violation that is minor or *cosmetic*. Only logged issues where usability is a problem will be graded with this scale.

After completion of the heurisitic evaluation, the overall application will be assessed by evaluators based on five areas of usability. Areas of learnability, efficiency, memorability, errors, satisfaction of the overall application will be scored on a seven-point Likert scale, where one is *unacceptable* and seven *exceeds* expectations.

User evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. Expert faculty and developers will evaluate the users by direct observation in conjunction with videotaping and interviews.

h. RISKS-BENEFITS ANALYSIS TO SUBJECT, RISKS TO THOSE CONDUCTING THE SUDY:

The information gained from the study will help in the education and learning experience of future students and preceptors. This research helps us learn more about the impact and potential benefit of the use of these advanced computing tools for improving the learning experience, as well as provide information on possible need for modification or improvements in these tools.

i. PRECAUTIONS:

The simulation components of this study are currently in use at multiple institutions and facilities and are not considered experimental. There are minimal to no risks involved in this study. There are no known psychological risks associated with this experiment.

In the virtual reality environment, participants may experience mild simulator sickness, which is characterized by temporary nausea, headache, visual disturbances, disorientation, and general discomfort. Individuals susceptible to motion sickness may choose not to participate.

All individuals will be informed that participation is voluntary and that they have the right to refuse to participate in any or all aspects of the study without any negative consequences. Included in consent for is participant acknowledgment that visual acuity is normal or corrected to normal, and that the participant does not suffer from motion sickness or migraine headaches.

Any and all adverse events will be reported to the Committee on Human Studies.

Precautionary procedures to limit access to, label, and securely store hard copy data, electronic data and video images will be implemented to prevent unauthorized access, destruction, alteration or removal, accidental or intended damage or destruction of the research data. research data will be stored securely in lockable fining cabinets or a lockable room with controlled access. Precautions for storing electronic data will be taken to control access to only those authorized.

9. DEPARTURE FROM PROTOCOL FOR INDIVIDUAL PATIENTS:
Any deviation to the protocol that may have an effect on the safety or rights of the subject or the integrity of the study must be reported to the USAMRMC ORP HRPO as soon as the deviation is identified.

10. ADVERSE REACTIONS REPORTING: All unanticipated problems involving risk to subjects or others, serious adverse events related to participation in the study and subject deaths related to participation in the study should be promptly reported by phone (301-619-2165), by email (hsrrb@det.amedd.army.mil), or by facsimile (301-619-7803) to the USAMRMC, Office of Research Protections, Human Research Protection Office. A complete written report will follow the initial notification. In addition to the methods above, the complete report will be sent to the U.S. Army Medical Research and Materiel Command, ATTN: MCMR-ZB-PH, 504 Scott Street, Fort Detrick, Maryland 21702-5012.

All unanticipated problems involving risk to subjects or others, serious adverse events related to participation in the study and subject deaths related to participation in the study should be promptly reported will also be immediately reported by telephone and in written report to the University of Hawaii Committee on Human Studies, 2540 Maile Way, Spalding Hall 253, Honolulu, HI 96822, (808.539.3955)

11. MODIFICATION OF PROTOCOL: Requests for modification will be provided in writing to the Chief, Department of Clinical Investigation, USAMRMC and to the University of Hawaii Committee on Human Studies. Major modifications to the research protocol and any modifications that could potentially increase risk to subjects must be submitted to the USAMRMC ORP HRPO for approval prior to implementation. All other amendments will be submitted with the continuing review report to the USAMRMC ORP HRPO for acceptance.

12. USE OF INFORMATION AND PUBLICATIONS ARISING FROM THE STUDY:
Any and all publications resulting will be presented for clearance prior to submission.

13. FUNDING IMPLICATIONS:

a. RESOURCES REQUIRED:
Required resources are fully funded through an MRMC/USAMRAA award HSRRB No. A-14006 (Proposal No. 06083002)) to University Clinical, Educational & Research Associates.

b. SPONSOR-PROVIDED SUPPLIES OR EQUIPMENT:
None, all equipment is furnished by other funding.

14. REPORTING

A copy of the approved continuing review report and the local IRB approval notification will be submitted to the USAMRMC ORP HRPO as soon as these documents become available. A copy of the approved final study report and local IRB approval notification will be submitted to the USAMRMC ORP HRPO as soon as these documents become available.

15. ROLES AND RESPONSIBLITES:

Lawrence Burgess, M.D. (PI), 15%, will lead this effort and provide oversight and coordination of the overall project in both technical and research/data collection areas. Dr. Burgess will also assist in the ddevelopment and evaluation both military and non-military relevant triage scenarios and assist in data analyses and reporting results

Dale Vincent, M.D. (Co-PI), 30%, will work closely with the PI in developing and evaluating both military and non-military relevant triage scenarios. Dr. Vincent will coordinate with University of Hawaii faculty in recruiting subjects and assist in overseeing research activities. He will also assist in data analyses and reporting results.

Benjamin Berg, M.D. (Senior Faculty), 5%, has extensive experience in education and training, as well as his knowledge of acute\critical care medicine will be valuable in building relevant triage scenarios. Dr. Berg will also help coordinate research activities for Phase I of this protocol. He will also assist in data analyses and reporting results

Andrei Sherstyuk, Ph.D (Senior Faculty), 50%, will be the technical support for the project. Dr. Sherstyuk will help set up and administer the virtual reality application.

Kathleen Kihmm Connolly M.S. (Program Manager), 50%, will assist in development and drafting of protocols, submission of protocols to three institutional review boards and MRMC ORP, monitoring study progress, and ensuring compliance with review boards and relevant regulatory agencies. She will help recruit and consent subjects, maintain study records, assist in data analyses and reporting results.

16. SIGNATURES: Signatures indicate review, concurrence, and ability to support protocol.

_____________________________________ _____________

Lawrence Burgess, MD — Date
Principal Investigator

_____________________________________ _____________

Dale Vincent, MD — Date
Co-Investigator

_____________________________________ _____________

Gary K. Ostrander Ph.D. — Date
Interim Dean, John A. Burns School of Medicine

APPENDIX A
ACQUISITION OF TRIAGE SKILLS RECRUITMENT FLYER

RESEARCH STUDY: VOLUNTEERS NEEDED

You are invited to participate in a research study entitled:

Manikin Training for Acquisition of Triage Skills

Dates of Study: ***15 March -31 May 2007 (Approximate dates)***

Deadline for enrollment: ***ongoing until 25 enrolled***

Start Time: ***Various – see Enrollment form for choices***

Compensation: ***$50 gift certificates for Ala Moana Shopping Center for a total of approximately 2 hours, which includes pre and post-test questionnaires, web-based training, self-confidence and learning environment surveys, manikin training and breaks.***

Eligibility:

- ***Aged 18 years and older***
- ***Medical or allied health students (or recent graduate)***
- ***English speaking***
- ***Agree to volunteer after reading and understanding consent form***
- ***Normal vision (self reported normal or corrected to normal with glasses or contact lenses)***
- ***Normal hearing (self reported normal or corrected to normal with hearing aid)***

Number of volunteers needed: ***25 (chosen on a first come – first serve basis)***

Enrollment Instructions

1. ***If you are interested in participating in the Manikin Training for Acquisition of Triage Skills study, please email Kristen Okahashi, okahashi@hawaii.edu the attached ENROLLMENT FORM.***
3. ***You will be notified of your enrollment acceptance by e-mail (and be sent a map/easy directions to building and parking lot)***
4. ***Confirm you have received enrollment notification by replying to our e-mail***
5. ***Report to study location on date TBD.***

Manikin Training for Acquisition of Triage Skills - STUDY DETAILS

***Principal Investigator*: Lawrence Burgess, M.D.**
Telehealth Research Institute
John A. Burns School of Medicine
University of Hawaii

***Co-Investigators*: Dale Vincent, M.D.**
Telehealth Research Institute
John A. Burns School of Medicine
University of Hawaii

***Study Description*: Medical triage (sorting and treating patients) in mass casualty situations requires rapid decision-making. At a disaster site, triage may be the most important medical task performed. It is vital that first responders and medical personnel be thoroughly trained and prepared for action; however, there are few opportunities to obtain the training and experience necessary for optimal performance in mass casualty emergency situations.**

In this research study, participants will acquire triage knowledge through a short online course. Their triage skills will then be evaluated using simulated patients (manikins). Pre and post-test questionnaires will be administered before and after the online learning. All trainees will receive manikin training and feedback about their performance; this will facilitate research while providing training benefits to all the participants. Surveys about the learning environment and learner self-confidence will also be administered before and after the manikin training assessments.

***Location of Study*: Telehealth Research Institute**
John A. Burns School of Medicine
651 Ilalo Street, Medical Education Building
(the building near the flagpoles and flower sculpture)
Simulation Rm 1 and 2
University of Hawaii, Kaka'ako campus
PH: 808.692.1080
FX: 808.692.1250

***Parking*: Parking will be available in lot C of the UH Medical School Kaka'ako facility. The $3.00 parking fee will be refunded to you at the study registration desk.**

If you have questions regarding this study, please contact Dale Vincent by email dvincent@hawaii.edu, or by phone 808.692.1083.

*** * * * * * * * * ***

Thank you for your interest in our study!

Manikin Training for Acquisition of Triage Skills Research Study

ENROLLMENT FORM

Please note: Volunteers will be chosen on a first come – first serve basis until we reach our target number of 25

Name:

E-mail:

Mailing Address:

Phone: (best number to reach you)

Are you a student: ☐ ***YES*** ☐***NO***

If you have selected YES, please answer:

What institute are you attending:

What subject are you studying:

If you have selected NO, please answer:

When did you graduate:

From where did you graduate:

Degree or certificate:

What days are you available to participate (15 March -31 May 2007 (Approximate dates)):

Monday	***Tuesday***	***Wednesday***	***Thursday***	***Friday***
☐*9am – 11am*	☐*9am – 11am*	☐*9am – 11am*	☐*9am – 11am*	☐*9am – 11am*
☐*12pm – 2pm*	☐*12pm – 2pm*		☐*12pm – 2pm*	☐*12pm – 2pm*
☐*3pm – 5pm*	☐*3pm – 5pm*		☐*3pm – 5pm*	☐*3pm – 5pm*

Please e-mail this form to: okahashi@hawaii.edu or fax to Kristen Okahashi at 808.692.1250.

Thank you for your interest in our study!

APPENDIX B
CONSENT TO PARTICIPATE IN RESEARCH
SIMCENTERHAWAII TECHNOLOGY ENABLED LEARNING AND INTERVENTION SYSTEMS
PHASE I: MANIKIN TRAINING FOR ACQUISITION OF TRIAGE SKILLS

PURPOSE AND BACKGROUND

Lawrence Burgess, M.D., who is the Principal Investigator, from Telehealth Research Institute, John A. Burns School of Medicine, University of Hawaii, is conducting a research study to test the effectiveness of advanced computing tools, including virtual (computer generated) reality, manikin simulation, distance learning technology, and 3 dimensional objects, to see if they can enhance learning for health sciences students, first responders and medical personnel. The study is funded by the Department of Defense (DOD). You are being asked to participate in this research study because you are or have been a health sciences student. These advanced computing tools have been used in other research and teaching settings including in our medical school curriculum, with excellent results thus far. We hope to evaluate and determine the potential value of these methods to enhance the learning experience and the understanding of basic concepts related to associated learning objectives for first responders and medical personnel.

PROCEDURES

If you volunteer to participate in this study, the following things will happen.

Phase I: Simulation Training for Acquisition of Triage Skills
Learners will acquire triage knowledge through online didactic learning, and then be evaluated on manikins or the Virtual Reality (VR) Triage application as to how many triage skills were acquired. A total of 25 participants will be recruited for each study (manikin and VR Triage). The following components will be included in the study:

d) A traditional pre-test and post-test will be utilized to assess didactic knowledge gained through the online curriculum.
e) Determining the effect of simulation training on acquiring triage skills will be accomplished by identifying certain skills to be acquired and then assessing each learner in a total of three triage scenarios. Each scenario will have five different injured patients as portrayed by either manikins or in the VR environment. The initial assessment scenario following didactic learning will demonstrate the number of skills acquired from didactic learning.
f) In measuring the effect on self-efficacy and trainee satisfaction, students will complete a Reaction Questionnaire and Learning Environment Questionnaire, both three times each: before simulation training, after first simulation training scenario, and after the final simulation training experience.

All data that is published will be pooled aggregate data, with no way to match individual test scores to specific test-takers. Participation will take a total of about 2-3 hours over a period of 1 day. All studies involving UH students or preceptors will be conducted at the John A. Burns School of Medicine, University of Hawaii, Kakaako campus.

Experiment Description Phase I:

The application of advanced computer technology with anatomic, physiologic, and pharmacologic realism has increased the applicability to provide advanced simulation training in many areas of acute care medicine. We are studying the use of this technology to help scientists, educators, and engineers to better understand the potential impact on learning. The research design model tests two questions about simulation training in triage: is the addition of simulation training useful as opposed to didactic training alone, and if effective, how many training sessions are necessary?

All trainees will receive simulation training, thus all participants will benefit from the experimental training. In this design, learners serve as their own control as they receive didactic learning followed by simulation-based assessment\training. This study will not look at long-term skills retention, as short-term benefit of simulation training must be demonstrated first.

Prior to the experiment, participants will be oriented to the technology. All learners will have initial web-based didactic training, followed by live didactics. This includes live familiarization with the manikins or VR Triage application. Disease conditions and a set of 29 specific skills to be acquired will be described during didactics, as well as demonstrations of how to perform these actions. A pre- and post-test will be administered prior and after didactic training to determine if didactic knowledge has been acquired. Then sequential manikin or VR assessments will be conducted to determine if such sequential training results in increasing triage skills acquisition. During the experiment, participants will perform examinations of the manikin or VR patients in a simulated environment, in which performance will be evaluated by an expert. Students will complete a trainee satisfaction and self-efficacy questionnaire before starting the simulation training, after first simulation training scenario, and after the final simulation training experience.

After completion of all experimental and test sessions, participants will be given an opportunity to hear feedback regarding aggregate, group-specific test outcome data.

You are able to terminate your participation in the exercise at any time without penalty.

RISKS AND DISCOMFORTS

The simulation components of this study are currently in use at multiple institutions and facilities and are not considered experimental. There are minimal risks involved in this study. There are no known psychological risks associated with this experiment.

Due to the time commitments, participation may be caused inconvenience.

If you are participating in the VR Triage study, you may experience mild simulator sickness, due to using the head-mounted display, which is characterized by temporary nausea, headache, visual disturbances, disorientation, and general discomfort. By signing this consent form you acknowledge that your visual acuity is normal or corrected to normal, that you do not suffer from motion sickness or migraine headaches.

By signing this consent form you acknowledge that you have been informed that you can terminate your participation in this study at any time, for any reason and without adverse consequences. Also, that you understand that there may be unforeseeable risks related to this study and if you are injured in the course of this research procedure, you alone may be responsible for the costs of treating my injuries.

All information obtained will be kept and your identity will remain anonymous in reports of publications.

BENEFITS

The only benefit in participating in this study is the opportunity to receive experimental manikin or VR triage training. However, it is hoped that the information gained from the study will help in the education and learning experience of future students and preceptors. This research helps us learn more about the impact and potential benefit of the use of these advanced computing tools for improving the learning experience, as well as provide information on possible need for modification or improvements in these tools.

ALTERNATIVES TO PARTICIPATION

The only alternative is to not participate in this study.

CONFIDENTIALITY

Participation in research will involve a loss of privacy, but information about you will be handled as confidentially as possible. Representatives from the U.S. Army Medical Research and Materiel Command (USAMRMC), the University of Hawaii Human Research Review committee that oversees human subject research and the project administrators will have access to your information. Your name will not be used in any published reports about this study.

Precautionary procedures to limit access to, label, and securely store hard copy data, electronic data and video images will be implemented to prevent unauthorized access, destruction, alteration or removal, accidental or intended damage or destruction of the research data. research data will be stored securely in lockable fining cabinets or a lockable room with controlled access. Precautions for storing electronic data will be taken to control access to only those authorized.

COSTS OF STUDY

You will not be charged for any of the study procedures.

PAYMENT/COMPENSATION FOR PARTICIPATION

Students participating in the study will be compensated for their time.

All volunteer participants will receive a $50 gift certificate to Ala Moana Shopping Center for participating in the manikin or VR experiment. It is anticipated that the time you will spend will be approximately 2 hours participating in the experiment.

- Payment will be allowed only after completion of the final evaluation questionnaire. If the questionnaires are not completed, you will receive no compensation.

- You will receive a gift certificate immediately upon completion of the study.

AUTHORIZATION TO OBTAIN/UTILIZE IMAGES

Sometimes an image and/or part of a videotape clearly shows a particular feature or detail that would be helpful in teaching or when presenting the study results at a scientific presentation or in a publication.

By signing this consent form you acknowledge that you are over 18 years of ages and hereby grant permission to the University of Hawaii and its affiliates and subsidiaries to be photographed, and/or videotaped, and to allow the University of Hawaii and its affiliates and subsidiaries to use and/or permit others to use the images or videotapes in which you may appear in for teaching, scientific presentations and/or publications with the understanding that you will not be identified by name. By signing this consent, you acknowledge that you may withdraw this consent at any time without penalty. If you would like to withdraw consent for images/video in which you appear to be used, please contact:

Kathleen Kihmm Connolly
Program Manager
Telehealth Research Institute
John A. Burns School of Medicine
651 Ilalo Street, MEB, Suite 212
Honolulu, HI 96813

808.692.1089

NEW FINDINGS

You will be informed of any significant new findings that become available during the course of the study, such as changes in the risks or benefits resulting from participation in the research or new alternatives to participation that might change your mind about participating.

WITHDRAWAL

Your participation in this study is strictly voluntary. You have the right to choose not to participate or to withdraw your participation at any point in this study without prejudice to your future health care, education or other services to which you are otherwise entitled.

QUESTIONS

In the event of a research-related injury, or if you have any questions at any time about the research study, Dr. Burgess or his associates will be glad to speak to you at (808) 692-1080 during the hours of 8am - 5pm, Monday through Friday HI time. Or you can write to the following address:

Telehealth Research Institute
John A. Burns School of Medicine
651 Ilalo Street, MEB, Suite 212
Honolulu, HI 96813

If you have questions about your legal rights as a research subject, you may contact:

UH Committee on Human Studies
Phone: (808) 956-5007
2540 Maile Way
Honolulu, Hawaii, 96822.

CONSENT

You will be given a copy of this consent form to keep. By signing this consent form, you are not waiving any of your legal rights, claims, or remedies. If you have questions about your legal rights as a research subject, you may contact the Committee on Human Studies at (808) 956-5007, or write them at 2540 Maile Way, Honolulu, Hawaii, 96822.

I have read (or someone has read to me) the information in this consent form. I have had an opportunity to ask questions and all of my questions have been answered to my satisfaction. By signing this consent form, I willingly agree to participate in this study.

____
Name of Subject (type or print)

Permanent Address:

____
Street

____
City, State, Zip Code

______________________________ ______________________________
Signature of Subject Date

APPENDIX C
CONSENT TO PARTICIPATE IN RESEARCH
SIMCENTERHAWAII TECHNOLOGY ENABLED LEARNING AND INTERVENTION SYSTEMS
PHASE II: EVALUATION OF THE VIRTUAL REALITY TRIAGE APPLICATION

PURPOSE AND BACKGROUND

Lawrence Burgess, M.D., who is the Principal Investigator, from Telehealth Research Institute, John A. Burns School of Medicine, University of Hawaii, is conducting a research study to test the effectiveness of advanced computing tools, including virtual (computer generated) reality, manikin simulation, distance learning technology, and 3 dimensional objects, to see if they can enhance learning for health sciences students, first responders and medical personnel. The study is funded by the Department of Defense (DOD). You are being asked to participate in this research study because you are or have been a health sciences student, professional first responder, a human factors or human-computer interaction expert. These advanced computing tools have been used in other research and teaching settings including in our medical school curriculum, with excellent results thus far. We hope to evaluate and determine the potential value of these methods to enhance the learning experience and the understanding of basic concepts related to associated learning objectives for first responders and medical personnel.

PROCEDURES

If you volunteer to participate in this study, the following things will happen.

Phase II: Evaluation of the Virtual Reality Applications

You will be either being asked to participate in the Virtual Reality (VR) Triage or VR Nephron application study. Participants will provide feedback as to their potential value, strengths and weaknesses as they relate to the immersive experience. A total of 5 expert evaluators and 5 user evaluators will be recruited for the evaluation of the VR Triage and the evaluation of the VR Nephron studies.

All data that is published will be pooled aggregate data, with no way to match individual test scores to specific test-takers. Participation will take a total of about 2-3 hours over a period of 1 day. All studies involving UH students or preceptors will be conducted at the John A. Burns School of Medicine, University of Hawaii, Kakaako campus.

Experiment Description Phase II:

We are studying the use of virtual reality technology to help scientists, educators, and engineers to better understand their computer software systems and potential impact on learning. The virtual reality environment is a high performance computing, multidimensional virtual laboratory for construction, simulation, evaluation, perception, and comprehension of complex software systems and simulations. This study is testing means of learning in the virtual environment. During the process you will be moving your virtual body around in the three dimensional graphical world. We will be testing various devices, such as motion tracker or mouse/joystick for locomotion, that provide position and velocity input to the graphics computer.

In the VR Triage study, you will be wearing a head-mounted computer display that will provide you with a visual representation of a virtual environment. This display allows you to see computer screen information while blocking out external visual information.

In the VR Nephron study a standard PC workstation will be utilized.

Prior to the experiment, you will be oriented to the technology.

- Heuristic evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. After completion of the application assessment portion, the evaluator will conduct an evaluation. Issues with the application will be logged and assigned to the associated heuristic criterion that is violated. Based on defined attributes of usability, evaluators will rank each of the heuristic criterion task on a seven-point Likert scale, where one is *severe* and seven is a violation that is minor or *cosmetic*. Only logged issues where usability is a problem will be graded with this scale.

  After completion of the heurisitic evaluation, the overall application will be assessed by evaluators based on five areas of usability. Areas of learnability, efficiency, memorability, errors, satisfaction of the overall application will be scored on a seven-point Likert scale, where one is *unacceptable* and seven *exceeds* expectations.

- User evaluators will first familiarize themselves with the application and then perform specified representative tasks in the virtual environment. Expert faculty and developers will evaluate the users by direct observation in conjunction with videotaping and interviews.

After completion of all experimental sessions, you will be given an opportunity to hear feedback regarding aggregate, group-specific test outcome data.

You are able to terminate your participation in the exercise at any time without penalty.

RISKS AND DISCOMFORTS

The virtual reality components of this study are currently in use at multiple institutions and facilities and are not considered experimental. There are minimal risks involved in this study. There are no known psychological risks associated with this experiment. If you are participating in the VR Triage study, you may experience mild simulator sickness, which is characterized by temporary nausea, headache, visual disturbances, disorientation, and general discomfort. Individuals susceptible to motion sickness may choose not to participate. By signing this consent form you acknowledge that your visual acuity is normal or corrected to normal, that you do not suffer from motion sickness or migraine headaches.

Due to the time commitments, participation may cause inconvenience.

By signing this consent form you acknowledge that you have been informed that you can terminate your participation in this study at any time, for any reason and without adverse consequences. Also, that you understand that there may be unforeseeable risks related to this study and if you are injured in the course of this research procedure, you alone may be responsible for the costs of treating my injuries.

All information obtained will be kept and your identity will remain anonymous in reports of publications.

BENEFITS

There will be no direct benefit to you from participating in this study. However, it is hoped that the information gained from the study will help in the education and learning experience of future students and preceptors. This research helps us learn more about the impact and potential benefit of the use of these advanced computing tools for improving the learning experience, as well as provide information on possible need for modification or improvements in these tools.

ALTERNATIVES TO PARTICIPATION

The only alternative is to not participate in this study.

CONFIDENTIALITY

Participation in research will involve a loss of privacy, but information about you will be handled as confidentially as possible. Representatives from the U.S. Army Medical Research and Materiel Command (USAMRMC), the University of Hawaii Human Research Review committee that oversees human subject research and the project administrators will have access to your information. Your name will not be used in any published reports about this study.

Precautionary procedures to limit access to, label, and securely store hard copy data, electronic data and video images will be implemented to prevent unauthorized access, destruction, alteration or removal, accidental or intended damage or destruction of the research data. research data will be stored securely in lockable fining cabinets or a lockable room with controlled access. Precautions for storing electronic data will be taken to control access to only those authorized.

COSTS OF STUDY

You will not be charged for any of the study procedures.

PAYMENT/COMPENSATION FOR PARTICIPATION

Students participating in the study will be compensated for their time.

- If you are participating as a “Heuristic Evaluator” you will receive a $250 honorarium for participating in the heuristic evaluation. This includes two iterations of the heuristic evaluation. It is anticipated that the time you will spend will be approximately 2 hours for each sessions, a total of 4 hours.

    - Payment will be allowed only after completion of the final heuristic evaluation. If the second heuristic evaluation is not completed, you will receive no compensation.

- You will be paid by check within 4 weeks of completion of the evaluations.

- If you are participating as a "User Evaluator" you will receive a $25 gift certificate to Ala Moana Shopping Center for participating in the manikin or VR evaluation experiment. It is anticipated that the time you will spend will be approximately 45 minutes participating in the experiment.

  - Payment will be allowed only after completion of the final evaluation questionnaire. If the questionnaires are not completed, you will receive no compensation.

  - You will receive a gift certificate immediately upon completion of the study.

AUTHORIZATION TO OBTAIN/UTILIZE IMAGES

Sometimes an image and/or part of a videotape clearly shows a particular feature or detail that would be helpful in teaching or when presenting the study results at a scientific presentation or in a publication.

By signing this consent form you acknowledge that you are over 18 years of ages and hereby grant permission to the University of Hawaii and its affiliates and subsidiaries to be photographed, and/or videotaped, and to allow the University of Hawaii and its affiliates and subsidiaries to use and/or permit others to use the images or videotapes in which you may appear in for teaching, scientific presentations and/or publications with the understanding that you will not be identified by name. By signing this consent, you acknowledge that you may withdraw this consent at any time without penalty. If you would like to withdraw consent for images/video in which you appear to be used, please contact:

Kathleen Kihmm Connolly
Program Manager
Telehealth Research Institute
John A. Burns School of Medicine
651 Ilalo Street, MEB, Suite 212
Honolulu, HI 96813

808.692.1089

NEW FINDINGS

You will be informed of any significant new findings that become available during the course of the study, such as changes in the risks or benefits resulting from participation in the research or new alternatives to participation that might change your mind about participating.

WITHDRAWAL

Your participation in this study is strictly voluntary. You have the right to choose not to participate or to withdraw your participation at any point in this study without prejudice to your future health care, education or other services to which you are otherwise entitled.

QUESTIONS

In the event of a research-related injury, or if you have any questions at any time about the research study, Dr. Burgess or his associates will be glad to speak to you at (808) 692-1080 during the hours of 8am - 5pm, Monday through Friday HI time. Or you can write to the following address:

Telehealth Research Institute
John A. Burns School of Medicine
651 Ilalo Street, MEB, Suite 212
Honolulu, HI 96813

If you have questions about your legal rights as a research subject, you may contact the UH Committee on Human Studies at (808) 956-5007, or write them at 2540 Maile Way, Honolulu, Hawaii, 96822.

CONSENT

You will be given a copy of this consent form to keep. By signing this consent form, you are not waiving any of your legal rights, claims, or remedies. If you have questions about your legal rights as a research subject, you may contact the Committee on Human Studies at (808) 956-5007, or write them at 2540 Maile Way, Honolulu, Hawaii, 96822.

I have read (or someone has read to me) the information in this consent form. I have had an opportunity to ask questions and all of my questions have been answered to my satisfaction. By signing this consent form, I willingly agree to participate in this study.

____
Name of Subject (type or print)

Permanent Address:

____
Street

____
City, State, Zip Code

____ ________________________________
Signature of Subject Date

Appendix D
Reaction to Triage Module Questionnaire
SimCenterHawaii Technology Enabled Learning and Intervention Systems

In order to determine the effectiveness of this module in meeting your needs and interests, we need your input. Please give us your reactions, and make any comments or suggestions that will help us serve you. Please choose the appropriate response after each statement. Your responses are and will be used to improve this module.

	Strongly Disagree						***Strongly Agree***
1. The material covered was relevant to my duties as a first responder	1	2	3	4	5	6	7
2. The course objectives were adequately explained.	1	2	3	4	5	6	7
3. The module was well organized.	1	2	3	4	5	6	7
4. The material was presented in an interesting way.	1	2	3	4	5	6	7
5. The module communicated the material effectively.	1	2	3	4	5	6	7
6. As the module progressed, my questions were answered.	1	2	3	4	5	6	7

- -

7. How was the pace of the module?	1	2	3	4	5	6	7
	Too slow						***Too fast***

8. How was the level of difficulty of the module?

1	2	3	4	5	6	7
Too Hard to understand						***Too easy***

APPENDIX E
Learning Environment Questionnaire
SimCenterHawaii Technology Enabled Learning and Intervention Systems

Instructions: For each of the items, please rate on a 1 to 5 scale what best describes your response to the item. Scale is from 1 being *Never* to a rating of 5 being *Always*.

1. I believe I will learn to be an effective first responder.

1	*2*	*3*	*4*	*5*
Never				*Always*

2. I feel confident that my patients will consider me an effective first responder.

1	*2*	*3*	*4*	*5*
Never				*Always*

3. I feel confident in my ability to prioritize the treatment of patients in a mass casualty situation.

1	*2*	*3*	*4*	*5*
Never				*Always*

4. I feel confident in my ability to prioritize the use of resources in a mass casualty situation.

1	*2*	*3*	*4*	*5*
Never				*Always*

5. I feel confident in my ability to identify high risk patients for immediate treatment in a mass casualty situation.

1	*2*	*3*	*4*	*5*
Never				*Always*

6. I believe my fellow students respect me.

1	*2*	*3*	*4*	*5*
Never				*Always*

7. I believe that the physician-patient relationship is the most important aspect in triage.

1	*2*	*3*	*4*	*5*
Never				*Always*

8. I believe that providing emotional support for my patients is as important as physical treatment.

1	*2*	*3*	*4*	*5*
Never				*Always*

APPENDIX F
Heuristics for the Virtual Reality Triage Application Evaluation

Directions: Evaluators will record all problems and errors and categorize them under the relevant usability heuristic listed. After all violations are recorded and categorized, the evaluator will rank the overall violation of the heuristics based on a seven-point Likert scale, where one is *severe* and seven is a violation that is minor or *cosmetic*. If there are no violations for the heuristic, only subjective comments should be given.

1. **Natural engagement.** The interaction in the virtual triage environment should approach the expectation of the user a much as possible. Ideally, the user should not be aware that the virtual environment is not reality.
   Violations: ______________________________

Severity of Overall Violations of the Heuristic:

1	2	3	4	5	6	7
Severe						*Cosmetic*

Comments:______________________________

2. **Compatibility with the user's task and domain.** The objects in the virtual triage environment (medical tools, office space, furniture, etc…) should correspond as close as possible to the expectation in the real world. This includes their behavior, affordance and task action.
   Violations: ______________________________

Severity of Overall Violations of the Heuristic:

1	2	3	4	5	6	7
Severe						*Cosmetic*

Comments:____

3. **Natural expression of action.** The representation of self should allow the user to act and explore in a natural and expected manner and not restrict physical actions. The absence of haptic feedback may hinder this area.
   Violations: ____

Severity of Overall Violations of the Heuristic:

1	2	3	4	5	6	7
Severe						*Cosmetic*

Comments:____

4. **Close coordination of action and representation.** The representation of self, behaviors and actions should map to the user's actions. The response time between the user's movements in the real world to that in the virtual world should take less then 200 ms to avoid potential motion sickness.
   Violations: ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

____

____

____

____

5. **Realistic feedback.** The effect of the user's actions on virtual objects should be immediately and conform to the user's perceptions, expectations and laws of physics.
   Violations: ____
   ____
   ____
   ____
   ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

____

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____

____

6. **Faithful viewpoints.** The visual representation of the triage virtual environment should map to the user's normal perception. Head movement and viewpoint changes should be rendered without delay.
   Violations: ____
   ____
   ____
   ____
   ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

7. **Navigation and orientation support.** The user should always be able to orient themselves in the virtual environment and be able to return to known, present positions.
   Violations: ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

8. **Clear entry and exit points.** How to enter and exit the virtual environment should be clearly communicated.
   Violations: ____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

____

____

____

____

9. **Consistent departures.** Design compromises or substitutions in the virtual environment should be consistent and clearly marked or communicated.
Violations: ____

____

____

____

____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

____

____

____

____

10. **Support for learning.** Active objects should have cues and, if necessary, have some sort of explanation of their purpose in the virtual environment.
Violations: ____

____

____

____

____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

____

____

____

____

11. Clear turn-taking. When the system initiates control of the environment, it should be clearly signaled and conventions should be established.
Violations: ____

____

____

____

____

Severity of Overall Violations of the Heuristic:						
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

____

____

____

____

12. **Sense of Presence.** The user's sense of present "being there" in the virtual world should be as natural as possible.
Violations: ____

____

____

____

____

Severity of Overall Violations of the Heuristic:

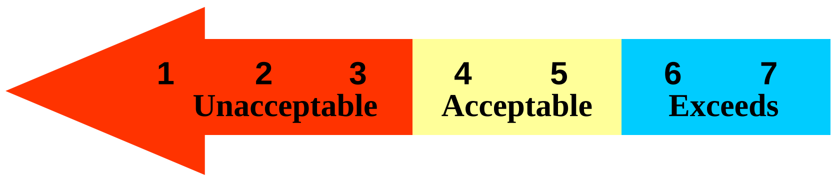
1	**2**	**3**	**4**	**5**	**6**	**7**
Severe						*Cosmetic*

Comments:____

APPENDIX G
Virtual Reality Target Usability

Instructions: For each of the items, please rate on a 1 to 7 scale where 1 – 3 is an *unacceptable* level (1 being worse than 3), 4-5 is an *acceptable* level (4 being less acceptable than 5), and 6-7 *exceeds* expectations (6 being less exceeds than 7).

- ***Learnability***: the system should be easy to learn, so that the user can rapidly start performing tasks in the environment.



- ***Efficiency***: The system should be efficient to use, once the user has learned how to use the virtual triage, objectives should be able to be accomplished similar to that of the real world.

- ***Memorability***: The system should be easy to remember, so that a user may return to the virtual triage environment without having to learn again how to use the interface.

- ***Errors***: The system should have a low rate of interface errors (i.e. errors trying to navigate, errors trying to apply tools, etc…), and if errors occur, users should be able to easily recover from them. Catastrophic error must not occur.

- ***Satisfaction***: The system should be pleasant to use, users must be satisfied and like using the system.

APPENDIX H
CURRICULUM VITAE

NAME AND POSITION

LAWRENCE P.A. BURGESS, M.D., F.A.C.S.

Associate Dean Government Affairs
Director of Telehealth Research Institute
Professor of Surgery
John A. Burns School of Medicine
University of Hawaii

ADDRESS

Home: 98-1754 Halakea St.
Aiea, HI 96701
Phone 808-486-6406
Fax 808-487-4801

Office: Telehealth Research Institute, MEB
651 Ilalo St.
Honolulu, HI 96813-5534
Phone 808-692-1091
Fax 808-692-1250

Clinical: 1329 Lusitana St., Ste.407
Honolulu, HI 96813
Phone 808-533-3368
Fax 808-536-4249

Email: lburgess@hawaii.edu
Email (home): burgesslpa@hawaii.rr.com

PERSONAL DATA

Date of Birth: September 16, 1954

Place of Birth: Honolulu, Hawaii

Citizenship: USA

EDUCATION

United States Military Academy West Point, NY	1972-1976	B.S.
John A. Burns School of Medicine University of Hawaii Honolulu, HI	1976-1980	M.D.

POST GRADUATE MEDICAL EDUCATION

Internship:	Flexible Tripler Army Medical Center, HI	1980-1981
Residency:	Otolaryngology-Head and Neck Surgery Tripler Army Medical Center, HI	1981-1985
Fellowship:	Head and Neck Surgery, sponsored by the Joint Council for Approval of Advanced Training in Head and Neck Oncologic Surgery Preceptor-Willard E. Fee, Jr., MD	1985-1986
	Facial Plastic and Reconstructive Surgery, sponsored by the American Academy of Facial Plastic and Reconstructive Surgery Preceptor-Richard L. Goode, MD	1985-1986
	Division of Otolaryngology-Head and Neck Surgery Stanford University Medical Ctr. Stanford, CA	

POSITIONS HELD

Flexible Intern Tripler AMC, HI	1980-1981
General Surgery Resident Tripler AMC, HI	1981-1982
Resident, Otolaryngology-Head and Neck Surgery Tripler AMC, HI	1982-1985
Clinical Instructor Division of Otolaryngology Stanford University Medical Ctr.	1985-1986
&	
Staff Surgeon Otolaryngology Section Palo Alto Veterans Administration Medical Ctr. Stanford, CA	1985-1986

Assistant Professor of Surgery	1986-1990
Associate Professor of Surgery	1990-1997
Clinical Professor of Surgery	1997-present
Uniformed Services University of the Health Sciences F.Edward Hebert School of Medicine Bethesda, MD 20814-4799	
Clinical Assistant Professor of Surgery, John A. Burns School of Medicine, Univ. of Hawaii	1991-2001
Staff, Otolaryngology-Head and Neck Surgery Service Walter Reed Army Medical Center Washington, D.C.	1986-1990
Assistant Chief, Otolaryngology-Head and Neck Surgery Service	1990-1994
Chief, Otolaryngology-Head and Neck Surgery Service and Program Director	1994-1997
Chief, Dept. of Surgery Tripler Medical Center Tripler, HI	1997-2001
Consultant to the Surgeon General Otolaryngology-Head and Neck Surgery	1996-2001
Associate Dean for Clinical Affairs	2002-2003
Assoc. Dean for Government Affairs	2004-present
Dir. Telehealth Research Institute	2002-present
John A. Burns School of Medicine University of Hawaii Honolulu, HI	

APPOINTMENTS AND COMMITTEES

Local:	President, Intern Class Tripler AMC, HI	1980-1981
	Hospital Education Committee Tripler Army Medical Center Tripler AMC, HI	1980-1981
	Hospital Education Committee Residency Review Subcommittee Tripler Army Medical Center Tripler AMC, HI	1984-1985

	President, Hawaii Society of Otolaryngology-Head and Neck Surgery	1991-1994
	Hospital Education Committee	1994-2001
	Surgical Case Review	1993-2001
	Dept of Surgery QA Director	1993-1994
	Associate QA Director	1994-1996
	Ethics Committee	1994-1997
	Laser Committee	1994-1997
	Assesment of Patients FMT,Chair	1997-2001
	Performance Improvement Council	1997-2001
	Managed Care Committee and Liason Subcommittee	1997-2001
	Risk Management Committee	1997-2001
	Executive Committee of the Medical Staff	1997-2001
	Credentials Committee	1997-2001
	Tripler Medical Center Tripler AMC, HI	
	American Cancer Society Hawaii Pacific	1997-2001
	Medical Advisor, Hui O'lelo (lost cord club)	
	American Cancer Society Hawaii Pacific	2004-2005
	Director at Large	
National:	American Academy of Otolaryngology-Head and Neck Surgery, Inc.	1988-1990
	Committee on Quality Assurance	1990-1993
	Telemedicine Task Force	1999-2002
	Program Advisory	1999-2005
	Facial Nerve	1999-2002
	American Academy of Facial Plastic and Reconstructive Surg.	
	Program Committee	1988-1991
	Research Committee	1990-1994 1994-1997 1997-Present
	Membership Committee	1997-Present
	American Society for Head and Neck Surgery	
	Prevention and Rehabilitation	1993-1999
	Program Committee	1993
	Medical News Reporter	1995

	American Board of Otolaryngology	
	Guest Examiner	1994,1995,1998
	Senior Examiner	2000-2004
	Laryngoscope (Journal) Reviewer	1995-Present
	Otolaryngology-Head and Neck Surgery Journal, Reviewer	1998-Present
	American Medical Association, Diagnostic and Therapeutic Technology Assessment Panel (DATTA)	1991-1998
	Society of Military Otolaryngologists	
	Secretary-Treasure	1987-1988
	Vice President	1988-1989
	President	1989-1990
	Pan Pacific Surgical Association Board of Trustees	1997-Present
Community:	Tripler Federal Credit Union	
	Board of Directors	1995-2001
	Supervisory Committee	1995-1996
	1st Vice Chairman	1996-1997
	Chairman	1997-1999
	Treasurer	2000-2001

OTHER PROFESSIONAL ACTIVITIES

Private Practice:

Lawrence Burgess, MD, LLC
1329 Lusitana St., Ste. 407
Honolulu, HI 96813, ph. 808-533-3368

Consulting: Medical Consultant: Records, Credentials Review
HMSA(Hawaii Medical Services Assn.-
Blue Cross-Blue Shield Hawaii)
US Army Claims Service
Medical Peer Review
ProPeer

LICENSURE AND CERTIFICATION

Diplomate of National Boards Parts I, II, III	July 1, 1981

State of Hawaii	July 12,1983
State of California (did not renew after military discharge)	Feb. 25,1985
Diplomate of the American Board of Otolaryngology, #291	Oct 25, 1985
Diplomate of the American Board of Quality Assurance and Utilization Review Physicians	Oct 25, 1998
Recertified	Oct 2000

AWARDS

Award winning paper- Hawaii Chapter of the American College of Surgeons(co-author)	1984
American Medical Association's Physician's Recognition Award in Continuing Medical Education	1986-1989
Military Region Award Winning Paper American College of Surgeons Committee on Trauma 1989 Residents'Paper Competition (co-author)	1989
Ira Tresley Research Award, American Academy of Facial Plastic and Reconstructive Surgery	1990
Certificate of Honor American Academy of Otolaryngology-Head and Neck Surgery	1990
Honorable Mention Candidate's Thesis American Laryngological, Rhinological and Otological Society	1992
Monograph Award American Academy of Facial Plastic and Reconstructive Surgery	1995

MILITARY AWARDS

National Defense Service Medal	1972,1992

Honor Graduate, Cadet Flight School	1974
Army Service Medal	1983
Overseas Tour Award	1983,1985
Meritorious Service Medal	1990,1996
"A" Designator-U.S. Army	1994
Order of Military Medical Merit,#3874	1995
Army Achievement Medal (3 awards)	1996, 1996, 1999
The Lewis Aspey Mologne Award (The 2000 Surgeon General’s Award for Military Academic Excellence)	2000

MILITARY EDUCATION

Officers Basic Course	1985
Advanced Trauma Life Support Instructor Course	1986
Advanced Cardiac Life Support Course	1995
Officers Advanced Course	1989
Command and General Staff College	1996

PROFESSIONAL SOCIETIES

‘Aha Hui ‘O Na Kauka
(Association of Native Hawaiian Physicians)

American Academy of Facial Plastic and Reconstructive Surgery

American Academy of Otolaryngology-Head and Neck Surgery

American College of Surgeons

American Laryngological, Rhinological and Otological Society

American Medical Association
#01401800057

American Society for Head and Neck Surgery

Hawaii Society of Otolaryngology

Pan Pacific Surgical Association
Board of Trustees

Society of Military Otolaryngologists

Society of University Otolaryngologists-
Head and Neck Surgery

PUBLICATIONS

JOURNALS

1. Burgess LP, VanSant TE, Yim DWS: Parotid Tumors. Military Med 1984;149:100-103.

2. Burgess LP, Lepore ML, Yim DWS: Bell's Palsy: The Steroid Controversy Revisited. Laryngoscope 1984;94:1472-1476.

3. Burgess LP, Quilligan JJ, Van Sant TE, Yim DWS: The External (Combination) Rhinoplasty Approach for The Problem Nose. J Otolaryngol 1985;14:113-119.

4. Quilligan JJ, Everton DM, Burgess LP, Robinson B, Perrone TP, Yim DWS: The External (Combination) Rhinoplasty Approach For Transsphenoidal Adenomectomy. J Otolaryngol 1985;14:192-196.

5. Burgess LP, Quilligan JJ, Yim DWS: Thyroid Cartilage Flap Reconstruction Of The Larynx Following Vertical Partial Laryngectomy. Laryngoscope 1985;95:1258-1261.

6. Burgess LP, Novia MV, Frankel SF, Hicks JM, Yim DWS: Avulsions of the Auricle. Ear Nose Throat J 1985;64:546-548.

7. Burgess LP, Yim DWS: Laryngeal Cyst Of The Thyroid Cartilage. Arch Otolaryngol Head Neck Surg 1985;111:826.

8. Burgess LP, Everton D, Quilligan JJ, Charles G, Lepore ML, VanSant TE, Yim DWS: Complications Of The External (Combination) Rhinoplasty Approach. Arch Otolaryngol Head Neck Surg 1986; 112:1064-1068.

9. Burgess LP:Pathologic quiz case 1:Sinus Histiocytosis with Massive Lymphadenopathy. Arch Otolaryngol Head Neck Surg 1986; 112:1296-1298.

10. Goode RL, Burgess LP, Glenn M, Schwarz M: Treatment Of Cervical Esophageal Stenosis With A Long-term Indwelling Prosthesis. Laryngoscope 1987;97:477-482.

11. Petroff M, Burgess LP, Anonsen C, Lau P: Cranial Bone Grafts for Post-Traumatic Facial Defects. Laryngoscope 1987;97:1249-1253.

12. Burgess LP, Quilligan JJ, Moe D, Lepore ML, Yim DWS: Congenital Multiple Fibromatosis (Infantile Myofibromatosis). Arch Otolaryngol Head Neck Surg 1988;114:207-209.

and for French Archives of Otolaryngology-Head and Neck Surgery;

Burgess LP, Quilligan JJ, Moe D, Lepore ML, Yim DWS: Fibromatose congenitale multiple (Myofibromatose juvenile). Archives of Otolaryngology-Journal d'O.R.L. 1988;7:111-115.

13. Schwartz MB, Burgess LP, Fee W, Donaldson S: Postirradiation Sarcoma in Retinoblastoma. Arch Otolaryngol Head Neck Surg 1988; 114:640-644.

14. Burgess LP, Yim DWS:Thyroid Cartilage Flap Reconstruction of the Larynx Following Vertical Partial Laryngectomy:An Interim Report. Laryngoscope 1988;98:605-609.

15. Burgess LP, Frankel S, Lepore ML, Yim DWS: Tuning Fork Screening for Sudden Hearing Loss. Military Med 1988;153:456-458.

16. Burgess LP, Lau P, Glenn M, Goode RL: Wound Tension in Rhytidectomy: A Preliminary Report. Arch Otolaryngol Head Neck Surg 1988;114:1280-1287.

17. Morin GV, Rand M, Burgess LP, Voussoughi J, Graeber G:Wound Healing:Relationship of Wound Closing Tension to Tensile Strength in Rats. Laryngoscope 1989;99:783-788.

18. Mitchell DA, Burgess LP:Pathological quiz case 1:Spindle cell carcinoma. Arch Otolaryngol Head Neck Surg 1990;116:110-112.

19. Burgess LP, Hessel CR:Software for Logging of Surgical Cases. Otolaryngol Head Neck Surg 1990;102:145-149.

20. Shank EC, Burgess LP, Geyer CA:Tornwaldt's Cyst: Case Report with Magnetic Resonance Imaging (MRI). Otolaryngol Head Neck Surg 1990;102:169-173.

21. Lepore ML, Burgess LP, Everton DE, Yim DWS: Mucoepidermoid Carcinoma of the Mandible. J Otolaryngol 1990;19:147-149.

22. Burton DM, Burgess LP: Nocardiosis of the Upper Aerodigestive Tract. Ear Nose Throat J 1990;69:350-353.

23. Burgess LP, Morin G, Rand M, Voussoughi J, Hollinger J: Wound Healing. Relationship of Wound Closing Tension to Scar Width in Rats. Arch Otolaryngol Head Neck Surg 1990;116:798-802.

24. Bach DE, Burgess LP, Zislis T, Quigley N, Hollinger JO: Cranial, Iliac, and Demineralized Freeze-Dried Bone Grafts of the Mandible in Dogs. Arch Otolaryngol Head Neck Surg 1991;117:390-395.

25. Morin GV, Shank EC, Burgess LP, Heffner D: Oncocytic Hyperplasia of the Pharynx. Otolaryngol Head Neck Surg 1991; 105:86-91.

26. Burgess LP, Drederian S, Morin GV, Zajtchuk JT: Immediate Postoperative Risk Following Uvulopalatopharyngoplasy for Obstructive Sleep Apnea. Otolaryngol Head Neck Surg 1992;106:81-86.

27. Kryzer TC, Gonzalez C, Burgess LP: Effects of Aerosolized Dexamethosone on Acute Subglottic Injury. Ann Otol Rhinol Laryngol 1992;101:95-99.

28. Bartels JW, Burgess LP: Nasal Dorsal Pseudocyst Formation Following Rhinoplasty. Am J Rhinology 1992;6:199-201.

29. Burgess LP, Goode RL:Injectable Collagen 1990. Facial Plastic Surg 1992;8:176-182.

30. Burgess, LP: Laryngeal Reconstruction following Vertical Partial Laryngectomy. Laryngoscope 1993;103:109-132.

31. Burgess LP, Casler J, Kryzer TC: Wound Tension in Rhytidectomy. Effects of Skin Flap Undermining and Superficial Musculoaponeurtotic System Suspension. Arch Otolaryngol Head Neck Surg 1993;119:173-177.

32. Murray S, Burgess LP, Wood G, Gonzalez C, Zajtchuk JT: Laryngocele Associated with Squamous Carcinoma in a 20-Year-Old Nonsmoker. Ear Nose Throat J 1994;73:156-158.

33. Sheridan MF, Bruns AD, Burgess LP: Hemiagenesis of the Thyroid. Otolaryngol Head Neck Surg 1995;112:621-623.

34. Tzikas TL, Vossoughi J, Burgess LP et al: Wound Healing: Effects of Closing Tension, Zyplast, and Platelet Derived Growth Factor. Laryngoscope 1996;106:322-327.

35. Picket B, Tzikas T, Vossoughi J, Burgess LPA: Wound Healing: Effects of Closing Tension and Time. Arch Otolaryngol Head Neck Surg 1996;122:565-568.

36. Visor RL, Sheridan MF, Burgess LP: Angiosarcoma of the Scalp. Otolaryngol-Head and Neck Surg 1997; 117:138.

37. Bailey RL, Sinha C, Burgess LP: Ketrolac Tromethamine and Hemorrhage in Tonsillectomy: A Prospective, Randomized, Double Blind Study. Laryngoscope 1997;107:166-169.

38. Tomaski SM, Mahoney EM, Burgess LP, Raines KB, Borneman M, Yim DWS: Sodium Ipodate (Oragrafin) in the Preoperative Preparation of Grave's Hyperthyroidism. Laryngoscope 1997;107:1066-1070.

39. Gross RD, Sheridan MF, Burgess LP: Endoscopic Sinus Surgery Complications in Residency. Laryngoscope 1997; 107:1080-1085.

40. Syms M, Singson M, Burgess LP: Evaluation of Cranial Nerve Disorders IX, X, XI, XII. Otolaryngol Clin North Am 1997;30:849-863.

41. Syms M, Burton B, Burgess LP: Magnetic Resonance Imaging in Carotidynia. Otolaryngol Head Neck Surg 1997; 117:S156-159.

42. Bruns AD, Burgess LP: Familial Recurrent Facial Paresis: Four Generations. Otolaryngol Head Neck Surg 1998; 118:859-862.

43. Burgess LP, Holtel MR, Syms M, etal: Overview of Telemedicine Applications for Otolaryngology. Laryngoscope 1999; 109:1433-37.

44. Ramsey MJ, DerSimonian R, Holtel MR, Burgess LP: Corticosteroid Treatment for Idiopathic Facial Nerve Paralysis: A Meta-analysis. Laryngoscope 2000; 110:335-341.

45. Gross R, Burgess LP, Holtel MR, etal: Saline Irrigation in the Prevention of Otorrhea After Tympanostomy Tube Placement. Laryngoscope 2000; 110:246-249.

46. Burton BS, Syms MJ, Peterman GW, Burgess LP: MR Imaging of Patients with Carotidynia. Am Journal of Neuroradiol 2000; 21:766-769.

47. Burgess LP, Syms MJ, Holtel MR et al: Telemedicine: Teleproctored Endoscopic Sinus Surgery. Laryngoscope 2002; 112:216-219.

48. Burgess LP, Holtel MR, Saiki SM et al: Telemedicine in Otolaryngology – Implications, Pitfalls and Roadblocks. Current Opinion in Otolaryngol Head Neck Surg 2002;10:194-198.

49. Holtel MR, Burgess LP: Telemedicine in otolaryngology, Otolarngol Clin NA 2002;35:1263-1281.

50. Jacobs JL, Von Platen M, Burgess LPA: The University of Hawaii Telemedicine Project: A Web-based telemedicine curriculum for health care providers. Hawaii Med J 2003;62:284.

51. Mashima PA, Birkmire-Peters DP, Syms MJ, Holtel MR, Burgess LPA, Peters LJ: Telehealth: Voice Therapy Using Telecommunications Technology. American Journal of Speech-Language Pathology 2003;12:432-439.

52. Burgess LP, Garshnek V, Birkmire-Peters D, Seifried SE: Distance Learning on the Internet: Web-based Archived Curriculum. Hawaii Med J 2004;63:287-290.

Books

Burgess LPA and Goode RL: Reanimation of the Paralyzed Face, Thieme Medical Publishing, 1994.

Web Site

Burgess LPA, Torrington K: Military Unique Curriculum Web Site, Editor and Principal Investigator, 2001-2002.

Textbook Chapters

1. Goode RL, Burgess LPA: Bone And Cartilage Grafts, in English(ed): Otolaryngology. Vol. 4, Chapter 7A, 1988, pp 1-14.

2. Goode RL, Burgess LPA: Injectable Collagen, in JR Thomas, GR Holt(ed): Facial Scars: Incisions, Revision, and Camouflage. St. Louis, C.V. Mosby Co., 1988, pp. 337-347.

3. Goode Rl, Burgess LPA: Collagen Implantation Technics, in JR Thomas, J Roller(ed):Cutaneous Facial Surgery. New York, Thieme Inc., 1992, pp.91-95.

4. Burgess LPA, Goode RL: Rehabilitation of Facial Nerve Injury, in MC Weisler, HC III Pillsbury(eds): Complications of Head and Neck Surgery. New York, Thieme Medical Publishers, 1995, pp.352-370.

5. Burgess LPA: Large Facial Wounds. Current Therapy in Otolaryngology-Head and Neck Surgery, G Gates, ed. St Louis, Mosby, 6th Edition, 1998; pp.490-92.

Abstracts

1. Burgess LP, Quilligan JJ, Lepore ML, Yim DWS: Submucosal False Cord Lesions Of The Larynx. Otolaryngology-Head and Neck Surgery, September 1984, p.70.

2. Burgess LP, Yim DWS: Thyroid Cartilage Flap Reconstruction Of The Larynx Following Vertical Partial Laryngectomy. Otolaryngology-Head and Neck Surgery, September 1984, p.39.

3. Lepore ML, Everton DM, Burgess LP, Quilligan JJ: Aberrant Salivary Gland Tumor: Mucoepidermoid Carcinoma Of The Mandible. Otolaryngology-Head and Neck Surgery, September 1984, p. 43.

4. Lepore ML, Everton DM, Burgess LP, Quilligan JJ: Central Mucoepidermoid Carcinoma Of The Mandible. Otolaryngology-

Head and Neck Surgery, September 1984, p. 70.

5. Burgess LP, Novia MV, Frankel SF, Moe RD, Everton DM:Massive Cervical Lymphadenopathy In Pacific Islanders. Otolaryngology-Head and Neck Surgery, September 1985, p. 85.

6. Quilligan JJ, Yim DWS, Burgess LP, Lepore ML, Moe RD:Congenital Myofibromatosis. Otolaryngolgoy-Head and Neck Surgery, September 1985, p.85.

7. Frankel SF, Moe RD, Burgess LP, Yim DWS:Extensive Corner Of The Mouth Carcinoma. Otolaryngology-Head and Neck Surgery, September 1985, p.90.

8. Frankel SF, Moe RD, Burgess LP, Novia MV,Yim DWS: Reconstruction Of The Anterior Mandible. Otolaryngolgoy-Head and Neck Surgery, September 1985, p.94.

9. Petroff MA, Burgess LP, Anonsen C, Lau P, Goode RL:Cranial Bone Grafting for Post Traumatic Defects. The American Laryngological, Rhinological and Otological Society Programs of the Section Meetings 1987, p. 8.

10. Burgess LP, Yim DWS: Thyroid Cartilage Flap Reconstruction of the Larynx Following Vertical Partial Laryngectomy:An Interim Report. The American Laryngological, Rhinological and Otological Society, Inc., Programs of the Section Meetings 1988, p. 20.

11. Shank EC, Burgess LPA, Geyer CA:Tornwaldt's Cyst:Case Presentation with Magnetic Resonance Imaging(MRI). Otolaryngology-Head and Neck Surgery 99(2):196, 1988.

12. Mitchell DA, Burgess LPA, Casler JD, Hauck KW:Nocardial Vallecular Cyst. Otolaryngology-Head and Neck Surgery 99(2):199, 1988.

13. Morin G, Rand M, Burgess LP, Voussoughi J, Graeber G:Wound Healing:Relationship of Closing Tension to Tensile Strength in Rats. The American Laryngological Rhinological and Otological Society, Inc., Programs of the Section Meetings 1989, p. 19.

14. Burgess LP, Quilligan JJ, Everton D, Charles G, Lepore ML, VanSant T, Yim D:Complications of the External (Combination) Rhinoplasty Approach. Year Book of Plastic and Reconstructive Surgery 1988,pp. 184-186.

15. Mitchell DA, Burgess LP:Osteosarcoma of the Maxilla. Otolaryngology-Head and Neck Surgery 100:241, 1989.

16. Shank EC, Morin GV, Burgess LP, Heffner D:Oncocytic Hyperplasia of the Larynx. Otolaryngology-Head and Neck Surgery 100:229, 1989.

17. Kryzer TC, Burgess LP:Glossopharyngeal Neuralgia with Syncope. Otolaryngology-Head and Neck Surgery 100:240, 1989.

18. Petroff M, Burgess LP, Anonsen C, Lau P: Cranial Bone Grafts for Post-Traumatic Facial Defects. Year Book of Otolaryngology-Head and Neck Surgery 1989, pp. 230-231.

19. Burgess LP, Lau P, Glenn M, Goode RL:Wound Tension in Rhytidectomy. Accepted for abstracting in the Year Book of Otolaryngology-Head and Neck Surgery 1990.

20. Tomaski SM, Burgess LP: Otolaryngologic Manifestations of Cornelia de Lange Syndrome. Otolaryngology-Head and Neck Surgery 105:287, 1991.

21. Burgess LP, Drederian S, Morin GV, Zajtchuk JT: Immediate Postoperative Risk Following Uvulopalatopharyngoplasy for Obstructive Sleep Apnea. Otolaryngol Head Neck Surg 103:186, 1990.

22. Pickett BP, Burgess LP, Brammer R, Roth M:Synchronous Cervical Paragangliomas Manifesting as a Parapharyngeal Mass. Otolaryngology-Head and Neck Surgery 105:284, 1991.

23. Bartels JW, Burgess LP: Nasal Dorsal Pseudocyst Formation Following Rhinoplasty. The American Laryngological Rhinological and Otological Society, Inc., Programs of the Section Meetings 1992, p.14.

24. Burgess LP, Drederian S, Morin GV, Zajtchuk JT: Immediate Postoperative Risk Following Uvulopalatopharyngoplasy for Obstructive Sleep Apnea. Clinical Digest Series, In Press.

25. Bailey RL, Sinha CK, Burgess LP:Cystic Schwannoma of the Trigeminal nerve. Otolaryngol Head Neck Surg 109:294, 1993.

26. Bruns AD, Sheridan MJ, Burgess LP: Hemiagenesis of the Thyroid. Otolaryngol Head Neck Surg 109:316, 1993.

27. Tzikas TL, Vossoughi J, Burgess LP et al: Wound Healing: Effects of Increased Closing Tension, Zyplast, and Platelet Derived Growth Factor. Proceedings of the 12th Southern Biomedical Engineering Conference, Tulane University, New Orleans, LA, April 2-4, 1993.

28. Bruns AD, Burgess LP: Facial Paralysis in 4 Generations. Otolaryngol Head Neck Surg 110: , 1994.

29. Burgess LP, Casler J, Kryzer TC: Wound Tension in Rhytidectomy. Effects of Skin Flap Undermining and Superficial Musculoaponeurtotic System Suspension. Year Book of Dermatologic Surgery, C.V. Mosby, 1994.

30. Syms M, Burton B, Burgess LP: Carotidynia and MRI Imaging. Otolaryngol Head Neck Surg 1995;111:

31. Bailey RL, Sinha C, Burgess LP: Ketrolac and Bleeding in Tonsillectomy. A Prospective, Randomized, Double-Blind Study. The American Laryngological Rhinological and Otological Society, Inc., Programs of the Section Meetings 1996, p 48.

32. Tomaski SM, Mahoney EM, Burgess LP, Raines KB, Borneman M, Yim DWS: Sodium Ipodate (Oragrafin) in the Preoperative Preparation of Grave's Hyperthyroidism. The American Laryngological Rhinological and Otological Society, Inc., Programs of the Section Meetings 1996, p 37.

33. Suk S, Sheridan MF, Burgess LPA:Transfacial Approaches to Anterior Skull Base Tumors. Otolaryngol Head Neck Surg 1996;115:P188.

34. Gross R, Sheridan MF, Burgess LPA: Endoscopic Sinus Surgery Complications in Residency. The American Laryngological, Rhinological and Otological Society, Inc., Programs of the Section Meetings 1997.

35. Burgess LP, Johnson R: Bone Grafts, A Comprehensive Overview (1 hr Instruction Course). Otolaryngology-Head and Neck Surgery 1997, Instruction Courses.

36. Ramsey M, Holtel M, Burgess LP: Telemedicine Applications in Otolaryngology. Otolaryngology-Head and Neck Surgery, Program of the Annual Meeting, 1997.

37. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). Otolaryngology-Head and Neck Surgery 1997, Instruction Courses.

38. Huyn T, Burgess LP, Holtel MR, Peters LJ, Birkmire-Peters DP: Burgess LP: Teleproctored Surgery. Telemedicine J 1998;4:123.

39. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). Otolaryngology-Head and Neck Surgery 1998, Instruction Courses.

40. Holtel M, Burgess LP, Peters LJ, Birkmire-Peters DP, Tomaski SM: A PC-Based Telemedicine System in Examination of the Ears, Nose, and Throat. Telemedicine J 1998;4:113.

41. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). Otolaryngology-Head and Neck Surgery 1999, Instruction Courses.

42. Syms M, Syms C, Burgess LP, Holtel M: Voice Recognition Software, Otolaryngology-Head and Neck Surgery, Instruction Courses, 1999.

43. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). Otolaryngology-Head and Neck Surgery 2000, Instruction Courses.

44. Hall DJ, Burgess LP: Failed Gore-Tex Slings in Facial Reanimation, Otolaryngology-Head and Neck Surgery Official Program, 2000.

45. Syms M, Syms C, Burgess LP, Holtel M: Voice Recognition Software, Otolaryngology-Head and Neck Surgery, Instruction Courses, 2000.

46. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). Otolaryngology-Head and Neck Surgery 2001.

47. Syms M, Syms C, Burgess LP, Holtel M: Voice Recognition Software, Otolaryngology-Head and Neck Surgery, Instruction Courses, 2001.

48. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). Otolaryngology-Head and Neck Surgery 2002.

49. Syms M, Syms C, Burgess LP, Holtel M: Voice Recognition Software, Otolaryngology-Head and Neck Surgery, Instruction Courses, 2002.

50. Onopa J, Le Pape M, Thonier G, Saiki S, Montgomery K, Burgess L: High Altitude Research Hawaii. High Altitude Medicine and Biology 2003;3:451.

51. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). Otolaryngology-Head and Neck Surgery 2003.

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Medical News Reports

1. Burgess LP: Mastoid Cavities Grafted With Cultured Epithelium Prepared From Autologous Epidermal Cells to Prevent Chronic Otorrhea. Arch Otolaryngol Head Neck Surg 117:957, 1991.

2. Burgess LP: The Learning Curve in Stapes Surgery. Arch Otolaryngol Head Neck Surg 117:1084, 1991.

3. Burgess LP:Spring Meeting of the Triological Society, April 14 and 15, 1992, Palm Desert, CA. Arch Otolaryngol Head Neck Surg 118:901-903, 1992.

Letters To The Editor

1. Burgess LPA, Yim DWS, Lepore ML:Letter To The Editor(on Bell's Palsy.) Laryngoscope 95:484-485, 1985.

2. Burgess LPA, Yim DWS, Lepore ML:Letter To The Editor(on Bell's Palsy.) Laryngoscope 95:1423, 1985.

3. Burgess LPA, Quilligan JJ, Lepore ML, Yim DWS:Chronic Sialadenitis in a Minor Salivary Gland(letter). ENT Journal 65:485-486, 1986.

PAPER PRESENTATIONS

1. Burgess LP, Wampler DE, Lynch E: Localized Heat Urticaria. Presented at Sloan-Ketterring Memorial Institute to Director Robert Good, MD, PhD, and Staff, New York, NY, April 1976.

2. Burgess LP, Quilligan JJ, VanSant TE, Yim DWS: The External (Combination) Rhinoplasty Approach for the Problem Nose. Presented to the Western Section of the American Academy of Facial Plastic and Reconstructive Surgery, Los Angeles, CA, January 1984.

3. Quilligan JJ, Burgess LP, Everton D, Robinson B, Perrone TP, Yim DWS: The External (Combination) Rhinoplasty Approach for Transsphenoidal Hypophysectomy. Presented to the Western Section of the American Academy of Facial Plastic and Reconstructive Surgery, Los Angeles, CA, January 1984, by Dr.Quilligan.

4. Everton D, Quilligan JJ, Burgess LP, Robinson B, Perrone TP, Yim DWS: The External (Combination) Rhinoplasty Approach for Transsphenoidal Hypophysectomy. Presented to the NOSE Symposium, Chicago, IL, June 1984, by Dr. Everton.

5. Quilligan JJ, Burgess LP, Everton DM, Robinson B, Perrone TP, Yim DWS: The External (Combination) Rhinoplasty Approach for Transsphenoidal Hypophysectomy. Presented to the Annual Meeting of the Hawaii Chapter of the American College of Surgeons, Honolulu, HI, June 1984, by Dr. Quilligan.

6. Burgess LP, Yim DWS: Thyroid Cartilage Flap Reconstruction of the Larynx Following Vertical Partial Laryngectomy. Presented to the American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Las Vegas, Nevada, September 1984.

7. Burgess LP, Quilligan JJ, Charles G, Lepore ML, VanSant TE, Everton DM, Yim DWS: Complications of the External (Combination) Rhinoplasty Approach. Presented to the Western Section of the American Academy of Facial Plastic and Reconstructive Surgery, Santa Barbara, CA, January 1985.

8. Schwarz M, Burgess LP, Fee WE,Jr:Radiation Induced Sarcomas of the Head and Neck. Presented to the American Society of Head and Neck Surgery, Palm Beach, Florida, May 9, 1986, by Dr. Schwarz.

9. Burgess LPA: External Rhinoplasty:Beyond the Approach. Presented at the Ninth Annual Alumni Day Program, Stanford University Medical Center, Stanford, California, June 27, 1986.

10. Petroff MA, Burgess LPA, Anonsen C, Lau P, Goode RL:Cranial Bone Grafting for Post-Traumatic Facial Defects. Presented to the Western Section of the Triological Society, Los Angeles, California, January 9, 1987, by Dr. Petroff.

11. Burgess LP, Glenn M, Lau P, Goode RL:Wound Tension in Rhytidectomy:The Classical Skin Flap vs. SMAS Plication. Presented to the Fall Meeting of the American Academy of Facial Plastic and Reconstructive Surgery, Chicago, ILL, 18-19 September 1987.

12. Burgess LP, Yim DWS: Thyroid Cartilage Flap Reconstruction of the Larynx Following Vertical Partial Laryngectomy:An Interim Report. Presented to the Southern Section of the Triological Society, Birmingham, AL, January 15-16, 1988.

13. Morin G, Rand M, Burgess LP, Voussoughi J, Graeber G:Wound Healing:Relationship of Closing Tension to Tensile Strength in Rats. Presented to the Southern Section of the Triological Society, Naples, FL, January 13, 1989, by Dr. Morin.

14. Morin G, Rand M, Burgess LP, Voussoughi J, Graeber G:Wound Healing:Relationship of Closing Tension to Tensile Strength in Rats. Presented to the American College of Surgeons, Committee on Trauma, Residents' Papers Competition, Vancouver, B.C., February 23, 1989, by Dr. Morin.

15. Kryzer TC, Gonzalez C, Burgess LP: Acquired Subglottic Injury and Response to Aerosolized Dexamethasone. Presented to the American Society of Pediatric Otolaryngology, San Diego, CA, May 19, 1989, by Dr. Kryzer.

16. Burgess LP, Morin G, Rand M, Voussoughi J, Hollinger J:Wound Healing: Scar Width Analysis and Relationship to Closing Tension. Presented to the American Academy of Facial Plastic and Reconstructive Surgery Fall Meeting, New Orleans, LA, September 22, 1989.

17. Burgess LP, Morin G, Edmond C: Biomechanical Aspects of Wound Healing. Presented to the Southern Sectional Meeting of the American Academy of Facial Plastic and Reconstructive Surgery, White Sulphur Springs, WV, January 11, 1990.

18. Burgess LP, Bach DE, Zislis T, Quigley N, Hollinger J: Cranial, Iliac, and Demineralized Freeze-Dried Bone Grafts of the Mandible in Dogs. Presented to the American Academy of Facial Plastic and Reconstructive Surgery Spring Meeting, W. Palm Beach, FL, May 5, 1990.

19. Burgess LP, Dederian S, Morin GV, Gonzalez C, Zajtchuk JT: Postoperative Risk Following Uvulopalatopharyngoplasty. Presented to the American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, 10 September 1990, San Diego, CA.

20. Bartels J, Burgess LP:Nasal Dorsal Cyst following Rhinoplasty. Presented to the Western Sectional Meeting of the Triologic Society, La Quinta, CA, January 1992, by Dr. Bartels.

21. Tzikas TL, Vossoughi J, Burgess LPA, Pickett BP, Brammer RE:Increasing the tensile strength of skin wound at early healing period. 12th Southern Biomedical Engineering Conference, Tulane Univ., New Orleans, LA, April 2-4, 1993, by Dr. Vossoughi.

22. Tzikas TL, Vossoughi J, Burgess LPA, Pickett BP, Brammer RE:Effects of Zyplast and Platelet derived growth factor on wound healing. International Facial Plastic and Reconstructive Surgery, San Francisco, CA, June 19-23, 1993, by Dr. Tzikas.

23. Picket B, Tzikas T, Vossoughi J, Burgess LPA: Wound Healing: Effects of Closing Tension and Time. COSM, Palm Beach, FL, April 1994, by Dr. Pickett.

24. Bailey RL, Sinha C, Burgess LP: Ketrolac and Bleeding in Tonsillectomy. A Prospective, Randomized, Double-Blind Study. The American Laryngological Rhinological and Otological Society, Inc., Western Section Meeting 1996, Jan 14, 1996, by Dr. Bailey.

25. Tomaski SM, Mahoney EM, Burgess LP, Raines KB, Borneman M, Yim DWS: Sodium Ipodate (Oragrafin) in the Preoperative Preparation of Grave's Hyperthyroidism. The American Laryngological Rhinological and Otological Society, Inc., Western Section Meeting 1996, Jan 13, 1996, by Dr. Tomaski.

26. Gross R, Sheridan MF, Burgess LPA: Endoscopic Sinus Surgery Complications in Residency. The American Laryngological, Rhinological and Otological Society, Inc., Western Section Meeting, Jan 12, 1997, by Dr. Gross.

27. Burgess LP, Goode R: Facial Reanimation. National Medical Association, Honolulu, HI, Aug 1997.

27. Burgess LP, Holtel M, Birkmire D, Peters: Telemedicine Applications in Otolaryngology, Institute for Telehealth and Telemedicine: Mapping the Future for Hawaii, Univ. of Hawaii, Sept. 26, 1997.

28. Burgess LP: Telemedicine Applications for the Future. Pan Pacific Surgical Association, Honolulu, HI, Jan. 29, 1998.

29 Burgess LP, Ramsey M, Holtel M: Bell's Palsy Update. Pan Pacific Surgical Association, Honolulu, HI, Jan. 28, 1998.

30. Burgess LP: Telemedicine Applications in Otolaryngology. Society of University Otolaryngologists Annual Meeting, Washington, D.C., Nov. 1, 1997.

31. Burgess LP, Holtel M: Teleheath. 29th Annual Straehley Symposium, Tripler Army Medical Center, HI, November 11, 1998.

32. Burgess LP: Teleproctored Surgery in Otolaryngology. Medicine Meets Virtual Reality:7, San Francisco, CA, January 21, 1999.
33. Gross R, Burgess LP, Holtel MR, etal: Post-Myringotomy Otorhea Middle Ear Irrigation vs Drops. Presented to the Western Section Meeting of the Triologic Society, January 1999.

34. Ramsey M, Burgess LP, Holtel M: Bell's Palsy: Meta Analysis of Steroid Therapy. Presented to the Western Section Meeting of the Triologic Society, January 1999.

35. Burgess LP: Overview of Telemedicine Applications in Otolaryngology. Presented to the Annual Meeting of the Triological Society, Palm Desert, CA, April 1999.

36. Birkmire-Peters D, Burgess LP, Syms M: Teleproctored Surgery in Otolaryngology. Medicine Meets Virtual Reality. San Diego, CA, January 2000.

37. Burgess LP: Telemedicine Overview, Asia-Pacific Military Medicine Conference, Singapore, May 10, 2000.

38. Birkmire-Peters D, Burgess LP, Syms M: Teleproctored Surgery in Otolaryngology. Medicine Meets Virtual Reality. San Diego, CA, January 2001.

39. Burgess LP, Garshnek V: Infectious Disease Surveillance, Bioterrorism Preparedness Summit, East-West Center, Honolulu, HI, October 2003.

40. Burgess LP: University of Hawaii: Advanced Health Care Technologies, Medicine Meets Virtual Reality, TATRC Pre-meeting Break Out, Newport Beach, CA, January 2004.

41. Burgess LP: Surgical Training through Simulation in Virtual Reality, Integrated Cancer Care, ASOT, Pattaya, Thailand, 24 October 2004.

42. Burgess LP: Simulation Workshop, Asia-Pacific Military Medical Conference, May 9-11, 2005, Hanoi,Vietnam.

POSTER PRESENTATIONS

1. Burgess LP, Quilligan JJ, Lepore ML, Yim DWS: Submucosal False Cord Lesions of the Larynx Causing Hoarseness. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Las Vegas, Nevada, September 1984.

2. Lepore ML, Everton DM, Burgess LP, Quilligan JJ: Central

Mucoepidermoid Carcinoma of the Mandible: Difficulties in Diagnosis and Treatment. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Las Vegas, Nevada, September 1984, by Dr. Lepore.

3. Lepore ML, Everton DM, Burgess LP, Quilligan JJ: Aberrant Salivary Gland Tumor-Mucoepidermoid Carcinoma of the Mandible. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Las Vegas, Nevada, September 1984, by Dr. Lepore.

4. Burgess LP, Frankel S, Moe RD, Novia MV, Everton DM:Massive Cervical Lymphadenopathy in Pacific Islanders. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Atlanta, Georgia, October 1985.

5. Quilligan JJ, Yim DWS, Burgess LP, Moe RD, Lepore ML: Congenital Myofibromatosis. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Atlanta, Georgia, October 1985, by Dr. Quilligan.

6. Frankel SF, Moe RD, Burgess LP, Novia MV, Yim DWS:Reconstruction of the Anterior Mandible. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Atlanta, Georgia, October 1985, by Dr. Frankel.

7. Frankel SF, Moe RD, Burgess LP, Yim DWS:Extensive Corner of the Mouth Carcinoma. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Atlanta, Georgia, October 1985, by Dr. Frankel.

8. Vossoughi J, Burgess LP, Morin G, Rand M:The Effect of Skin Closing Tension on Wound Tensile Strength. World Congress on Medical Physics and Biomedical Engineering, San Antonio, TX, August 6-12, 1988, by Dr. Vossoughi.

9. Shank EC, Burgess LPA, Geyer CA:Tornwaldt's Cyst:Case Presentation with Magnetic Resonance Imaging(MRI). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Washington, D.C., September 1988, by Dr. Shank.

10. Mitchell DA, Burgess LPA, Casler JD, Hauck KW:Nocardial Vallecular Cyst. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Washington, D.C., September 1988, by Dr. Mitchell.

12. Mitchell DA, Burgess LP:Osteosarcoma of the Maxilla. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, New Orleans, LA September 24-28, 1989, by Dr. Mitchell.

13. Kryzer TC, Burgess LP:Glossopharyngeal Neuralgia with Syncope. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, New Orleans, LA September 24-28, 1989, by Dr. Kryzer.

14. Sheridan M, Burgess LP:Undifferentiated Carcinoma vs. Eosinophilic Granuloma in an Adolescent Male. American Society of Pediatric Otolaryngology, Waikoloa, HI, May 9-11, 1991, by Dr. Sheridan.

15. Tomaski S, Burgess LP:Cornelia de Lange Syndrome. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Kansas City, MO, September 1991 by Dr. Tomaski.

16. Pickett BP, Burgess LP, Brammer R, Roth M:Synchronous Cervical Paragangliomas Manifesting as a Parapharyngeal Mass. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Kansas City, MO, September 1991 by Dr. Pickett.

17. Bailey RL, Sinha CK, Burgess LP:Cystic Schwannoma of the Trigeminal nerve. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Minneapolis, MN, October 1993 by Dr. Bailey.

18. Bruns AD, Sheridan MJ, Burgess LP: Hemiagenesis of the Thyroid. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Minneapolis, MN, October 1993 by Dr. Bruns.

19. Bruns AD, Burgess LP: Facial Paralysis in 4 Generations. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, San Diego, CA, September 1994 by Dr. Bruns.

20. Syms M, Burton B, Burgess LP: Carotidynia and MRI Imaging. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, New Orleans, LA September 17-20, 1995, by Dr. Syms.

21. Suk S, Sheridan MF, Burgess LPA:Transfacial Approaches to Anterior Skull Base Tumors. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Washington, D.C., September 29-2 Oct, 1996, by Dr. Suk.

22. Ramsey M, Holtel M, Burgess LP: Telemedicine Applications in Otolaryngology. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, San Francisco, CA, September 7-11, 1997.

23. Huyn T, Burgess LP, Holtel M, Peters LJ, Birkmire-Peters D: Teleproctored Surgery. American Telemedicine Assn. Annual Meeting, Orlando, FL, April 6, 1998.

24. Holtel M, Burgess LP, Tomaski S, Peters L, Birkmire-Peters D: A PC Based Telemedicine System in Examination of the Ears, Nose, and Throat. American Telemedicine Assn. Annual Meeting, Orlando, FL, April 6, 1998.

25. Syms M, Burgess, L: Teleproctored Surgery in Otolaryngology. American Telemedicine Assn. Annual Meeting, Salt Lake City, UT, April 19-20, 1999.

26. Hall DJ, burgess LP: Failed Gore-Tex Slings in Facial Reanimation, Annual Meeting, Otolaryngology-Head and Neck Surgery, Washington, D.C., Sept. 25-28, 2000.

27. Burgess LPA, Syms MJ, Holtel MR, Birkmire-Peters DP, Johnson RE, Ramsey MJ: Poster Presentation, Telemedicine: Teleproctored Endoscopic Sinus Surgery. Triological Society, Palm Springs, CA, May 13-15 2001.

28. Onopa J, Le Pape M, Thonier G, Saiki S, Montgomery K, Burgess L: High Altitude Research Hawaii. 13th International Hypoxia Symposium, February 19-22, 2003.

COURSE/PROGRAM DIRECTOR, COURSE FACULTY PRESENTATIONS, PANELS, VISITING PROFESSOR

1. Maxillofacial Trauma Symposium, with Drs. Richard and Jean Holt. Presentation-Trauma to the Ear and Temporal Bone-Tripler Army Medical Center, Hawaii, February 1985.

2. Soft Tissue Workshop-Dr. Ted Cook
Soft Tissue Laboratory Instructor
Tripler Army Medical Center, Hawaii, February 1985.

3. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, 1 Hour Course, 1985, 1986, 1987, 1988, 1989, 1990. The External (Combination) Rhinoplasty Approach: Access for Problem Management. With Van Sant TEJr., Yim DWS

4. Head and Neck Oncology Symposium
Tripler Army Medical Center, January 1986.
Presentations-
A. Iodine 125 Implants in the Treatment of Neck Metastasis.
B. Irridium 192 Implants in the Treatment of Base of Tongue and Tonsil-Palatine Carcinomas.

5. Ninth Annual Alumni Day Program
Program Co-Director with Shinn J.
Division of Otolaryngology-Head and Neck Surgery
Stanford University Medical Center, June 1986.
A. Presentation-Partial Laryngeal Surgery.

6. Implants in Facial Plastic and Reconstructive Surgery-1986.
Course Co-Director with Goode RL.
Division of Otolaryngology-Head and Neck Surgery
Stanford University Medical Center, June 1986.
A. Presentation-Zyplast, Early Experiences.
B. Panel Member-Facial Implants, "How I Do It."

7. AFIP Basic Science Course in Otolaryngology

Course Director
Armed Forces Institute of Pathology, Apr-May 1987,1988,1989
Presentations:
A. External Rhinoplasty
B. Brachytherapy in Head and Neck Oncology
C. Partial Laryngeal Surgery
D. Obstructive Sleep Apnea Syndrome
E. Calvarial Bone Grafting in Reconstructive Surgery
F. Anatomy Dissection Course-Laboratory Instructor

8. Soft Tissue Workshop
Course Co-Director with Robert Jarchow, MD
Armed Forces Institute of Pathology, Apr 21-22, 1987; Apr 18-19, 1988; Apr 19-20, 1989.
Presentations:
A. Local Flaps in Reconstructive Surgery of the Head and Neck
B. Facelift Surgery
C. Laboratory Instructor

9. Military Medicine Contingency Courses
Uniformed Services University of the Health Sciences
ATLS Lab Instructor
July 86-June 87, July 87-June 88, July 88-June 89.

10. Streit Seminar
Uniformed Services University of the Health Sciences
March 13-14, 1987
Panel Moderator:Meniere's Disease

11. Advanced Trauma Life Support Course:Instructor
Academy of Health Sciences, Ft. Sam Houston, TX
July 10-14, 1987

12. Streit Seminar
Uniformed Services University of the Health Sciences
March 17-18, 1988
Presentation: Partial Laryngectomy:Surgical Techniques
Panels: Surgical Approaches, Reconstruction.

13. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, 1 Hour Course, 1988, 1989, 1990. Software for Logging of Surgical Cases. With Carlos Gonzalez, MD, and Robert E. Brammer, MD.
14. 24th Annual Post Graduate Course in Oral Cancer, sponsored by WRAMC and the American Cancer Society, 30 April 1988, WRAMC. Presentation:Staging and Surgical Management of Oral Cavity Carcinoma.

15. Soft Tissue Workshop
Maxillofacial Trauma Symposium
May 31-June 2, Fitzsimmons AMC, Aurora, CO

Presentations:
A. Wound Healing.
B. Z-Plasty/W-Plasty
C. Calvarial Bone Grafting in Maxillofacial Trauma.

16. National Naval Medical Center, Otolaryngology Svc, Bethesda, MD, July 27, 1988
Presentation: Face-lift Surgery.

17. Yale University Medical Center
Section of Otolaryngology
Visiting Professor, September 28, 1989.
Presentations:
A. Face Lift Surgery
B. External Rhinoplasty

18. Streit Seminar
Uniformed Services University of the Health Sciences
March 10-11, 1989
Panel Moderator: Salivary Gland Malignancies.

19. American Academy of Facial Plastic and Reconstructive Surgery Fall Meeting, New Orleans, LA, September 15-16, 1989.
Moderator:Paper presentations.

20. American Academy of Facial Plastic and Reconstructive Surgery Southern Sectional Meeting, White Sulphur Springs, WV, January 11, 1990. Moderator: Paper presentations.

21. Streit Seminar
Uniformed Services University of the Health Sciences
March 18-19, 1990
Panel Moderator: Surgical Approaches to Sinus Malignancy.

22. American Academy of Facial Plastic and Reconstructive Surgery
Fall Meeting, San Diego, CA, September 7, 1990
Moderator: Paper presentations.

23. ATLS Instructor, Combat Casualty Care Course, June 13-17, 1991, Ft. Sam Houston, TX.

24. Soft Tissue Workshop
Tripler Army Medical Center, HI, January 1991-1995
Faculty: Presentation: Wound Healing, and Laboratory Instructor.

25. Sixth International Symposium of Facial Plastic Surgery-Program Committee and Moderator, San Francisco, CA, June 1993.

26. Pan Pacific Surgical Conference
Honolulu, HI, January 27, 1992
Moderator: Sleep Apnea.

27. Madigan Army Medical Center, Facial Reconstructive Surgery Tacoma, WA, Aug.6-7, 1993
Presentation: Effects of SMAS and Skin Flap Undermining.

28. Walter Reed Army Medical Center. Vertical Partial Laryngectomy, August 2, 1994

29. ATLS Instructor, Combat Casualty Care Course, Ft. Sam Houston, TX, October 27-31, 1994.

30. Grand Rounds: Calvarial Bone Grafting. University of Texas San Antonio, TX, November 1, 1994.

31. Concepts in Otolaryngology, Madigan Army Medical Center. Presentations: 1. Concepts in Facial Reanimation, and 2. Calvarial Bone Grafting, Tacoma, WA, Aug. 5-6, 1995.

32. ENT Update for the Primary Care Physician, Tripler Army Medical Center. Presentations: 1. Neck and Oral Masses, 2. Acute Facial Paralysis, and 3. Reconstruction for Skin Cancer, Tripler, HI, January 19, 1996.

33. Multi-Disciplinary Approach to OSAS, Madigan Army Medical Center. Presentations: Perioperative Considerations; Panel, Tacoma, WA, August 8-9, 1997.

34. Burgess LP, Johnson R: Bone Grafts, A Comprehensive Overview (1 hr Instruction Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, San Francisco, CA, September 7-11, 1997.

35. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, San Francisco, CA, September 7-11, 1997.

36. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instruction Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, San Antonio, TX, September 13-16, 1998.

37. Burgess LP: Facial Nerve Reanimation I and II (15 Feb 99) Otolaryngology Update, Honolulu, HI, February 13-16, 1999.

38. Burgess LP: Roundtable discussions. Otolaryngology Update, Marriott Hotel, Maui, February 17-20, 1999.

39. ATLS Instructor, Combat Casualty Care Course, Ft. Sam Houston, TX, April 30-May 2, 1999.

40. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, New Orleans, LA, September 26, 1999.

41. Syms M, Burgess LP, Holtel M, Syms C: Voice Recognition Software (2 hour Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, New Orleans, LA, September 28, 1999.

42. Burgess LP: Telemedicine Technologies: 1. Robotics, 2. Virtual Reality, Scientific Symposium on Telemedicine. American Academy of Otolaryngology-Head and Neck Surgery, New Orleans, LA, September 29, 1999.

43. Art of Rhinoplasty Course Co-Director with Leslie Bernstein, MD, and Laboratory Instructor, San Francisco, CA, November 12-15, 1999.

44. Burgess LP: Local and Regional Flaps, Otolaryngology Update, Honolulu, HI, February 14, 2000.

45. Burgess LP: Round Table Discussions, Otolaryngology Update, Maui, HI, February 17-18, 2000.

46. Burgess LP: What's the Best Surgery for Snoring and Sleep Apnea? An Overview of Sleep Surgery, Streit Seminar, Bethesda, MD, March 17, 2000.

47. University of Nebraska Medical Center Dept of Otolaryngology, Omaha, NE. Visiting Professor, March 20, 2000.
Presentation: Rhinoplasty and External Rhinoplasty.

48. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Washington, D.C., September 25, 2000.

49. Syms M, Burgess LP, Holtel M, Syms C: Voice Recognition Software (2 hour Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Washington, D.C., September 25, 2000.

50. Burgess LP: Session Moderator, American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Washington, D.C., September 25 and 26, 2000.

51. Burgess LP: Teleproctored Surgery, as Panel Discussant for Miniseminar: Society of University Otolaryngologists (SUO): Technology and Academic Otolaryngology, American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Washington, D.C., September 27, 2000.

52. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Denver, CO, September 9-12, 2001.

53. Syms M, Burgess LP, Holtel M, Syms C: Voice Recognition Software (2 hour Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Denver, CO, September 9-12, 2001.

54. Burgess LP: Session Moderator. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Denver, CO, September 9-12, 2001.

55. Burgess LP: Avoiding Pitfalls in Rhinoplasty, Laboratory Instructor, Art of Rhinoplasty Course, Co-Director with Leslie Bernstein, MD, November 2-5, 2001.

56. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, San Diego, CA, September 2002.

57. Syms M, Burgess LP, Holtel M, Syms C: Voice Recognition Software (2 hour Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, San Diego, CA, September 2002.

58. Burgess LP: Session Moderator. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, San Diego, CA, September 2002.

59. Visiting Professor, Hong Kong Polytechnic University: Pitfalls in Telemedicine and Telesynergy, December 16, 2002.

60. Visiting Professor, Mahaidol University, Bangkok, Thailand: Telemedicine and Telesynergy: Strategies for Success, July 16, 2003.

61. Visiting Professor, University of Hong Kong, China: Telemedicine and Telesynergy: Strategies for Success, July 18, 2003.

62. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Orlando, FL, September 2003.

63. Syms M, Burgess LP, Holtel M, Syms C: Voice Recognition Software (2 hour Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Orlando, CA, September 2003.

64. Burgess LP: Session Moderator. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, Orlando, CA, September 2003.

65. Burgess LP, Goode RL: Concepts in Facial Reanimation (1 hr Instructional Course). American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, New York, NY, September 2004.

66. Burgess LP: Session Moderator. American Academy of Otolaryngology-Head and Neck Surgery Annual Meeting, New York, NY, September 2004.

67. University of Nebraska Medical Center Dept of Otolaryngology, Omaha, NE. Visiting Professor, March 21, 2005.
Presentation: Coding: The Other Side of the Curtain.

RESEARCH/GRANTS

1. Skin Tension Evaluation of Plication in Rhytidectomy. Burgess LPA, Glenn M, Lau P, Goode RL.

2. U.S. Army Institute for Dental Research, #D01184,Evaluation of Cranial Bone, AAA Bone, AAA Bone + BMP, and AAA Cranial Bone Grafts compared to Marrow grafts from the Iliac Crest in Dogs for Critical Size Mandibular Defects. Principal Investigator: Bach DE. 10% time allocated by Burgess, LP. $24,400, support period from October 1986-September 1988.

3. Walter Reed Army Institute of Research, #S09-87, A. Wound Healing:Relationship of Closing Tension to Tensile Strength. Principal Investigator:Morin G. 20% time allocated by Burgess LP.
B. Relationship of Scar Width to Closing Tension. Principal Investigator:Burgess LP, 20% time allocated. $17,700, support period from October 1987-September 1989.

4. Department of Clinical Investigation, Walter Reed Army Medical Center, #2584, Obstructive Sleep Apnea Syndrome:Immediate Postoperative Risk Following Uvulopalatopharyngoplasty. Principal Investigator, Burgess LP, 20% time allocated. $9000, support period July 1988-September 1990.

5. Department of Clinical Investigation, Walter Reed Army Medical Center, #2582, Wound Tension in Rhytidectomy:Wide Undermining vs.SMAS Plication. Principal Investigator, Burgess LP, 50% time allocated by Burgess LP. $2000, support period December 1987-September 1989.

6. Walter Reed Army Institute of Research, #S09-87(Addendum 1), I. Storage Methods Affecting Skin Tensile Strength in Rats. II. The Effect of Closing Methods on Scar Width. Principal Investigator, Edmond C., 20 % time allocated. $6500, support period from October 1988-September 1989.

7. Uniformed Services University of the Health Sciences, #R090AL-01, Cartilage Flap Reconstruction of the Larynx. Principal Investigator Burgess LP. 80% time allocated. $25,628, project period from 1 October 1988-30 June 1992(projected budget $70,000), current budget period 1 October 1989-30 September 1990.

8. Department of Clinical Investigation, Walter Reed Army Medical Center, #2597, Wound Healing: Development of Tensile Strength vs. Time for Wounds Closed Under Tension in Rats. Principal Investigator Pickett B., 10% time allocated. $15,000, project period from 1 October 1989-30 September 1990.

9. Department of Clinical Investigation, Walter Reed Army Medical Center, #2501, Wound Healing: Development of Tensile Strength vs. Time

for Wounds Closed Under Tension in Rats. Principal Investigator Livermore G., 10% time allocated. $16,608, project period from 1 October 1989-30 September 1990.

10. Walter Reed Army Medical Center, Wound Healing: The Effect of Platelet-Derived Growth Factor on the Tensile Strength of Wounds Closed Under Tension in Rats. Principal Investigator Tzikas, T., 10% time allocated. Project period from 1 April 1991-31 March 1991.

11. Tripler Army Medical Center, Effects of Toradol on Bleeding in Post-Tonsillectomy patients. Principal Investigator Sinha, C., 10% time allocated. Project period from 1 July 1992-30 Jan 1995.

12. Tripler Army Medical Center, Effects of Ipodate in the Preoperative Preparation of Graves Patients. Principal Investigator Bailey, R., 10% time allocated. Project period from 1 July 1993-1995.

13. Tripler Army Medical Center, Teleproctoring in Endoscopic Sinus Surgery. Principal Investigator Burgess, L., 20% time allocated. Project period from 1 Jan 97-30 Sept 02, $180,000 (year 1), $400,000 (year 2).

14. Tripler Army Medical Center, Evaluation of Tympanic membranes by Telemedicine images. Co-Investigator Burgess, L., 10% time allocated. Project period from 1 Jan 97-present, $130,000; 1997, $127,000; 1998, $300,000; 1999, $300,000.

15. Tripler Army Medical Center, A Military Unique Curriculum Web Site. Primary Investigator, 20% time allocated, through 28 Feb 02. Project Period from 1 August 2000-30 Sept 02, $277,000.

16. University of Hawaii Telemedicine Project, John A. Burns School of Medicine. Primary Investigator, 50% time allocated. Project period from 1 July 01-30 June 03, $2,000,000.

17. University of Hawaii, John A. Burns School of Medicine, Office of Medical Education. Freeman Foundation Award for Asia-Pacific Outreach programs, consultant, co-author of award, 5% time allocated (unsalaried). Project period from 1 Aug 02-31 July 03, $196,000

18. University of Hawaii, John A. Burns School of Medicine, Office of Medical Education. Freeman Foundation Award for Thailand-Hawaii Interactive Exchange Program. Principal Investigator, 0% time allocated (infrastructure grant). Project period from 1 Nov 02–31 October 04, $426,000.

19. University Clinical Research Education Associates. Telemedicine Assessment Native Hawaiian Community Clinics, Principal Investigator, 5% time allocated. Project Period 7 November 2002-15 August 2003, $36,000.

20. University Clinical Research Education Associates. SIMBIO Project in Biosensors and Virtual Reality and Simulation. Principal Investigator, 40% time allocated. Project Period 15 September 2002-14 September 2004, $3,019,573.

21. University Clinical Research Education Associates. Environmental Water Sensing Project. Principal Investigator, 5% time allocated. Project Period 15 September 2003-14 September 2004, $25,000.

22. University of Hawaii, John A. Burns School of Medicine, Telemedicine Project, Bioterrorism Preparedness Infectious Disease, Principal Investigator, 10% of time allocated. Project period 1 Jan 03 - 31 December 05, $635,000.

23. University of Hawaii, John A. Burns School of Medicine, Genetic Screening in Native Hawaiians with End-Stage Renal Disease, Principal Investigator, 5% of time allocated. Project period 1 October 2004-30 September 2006, $415,428.

24. University of Hawaii, John A. Burns School of Medicine, IMITS Program, UPMC. Principal Investigator, 25% of time allocated. Project period 15 November 2004-14 November 2006, $500,000.

APPENDIX I

CITI Course in The Protection of Human Research Subjects

Saturday, February 19, 2005

CITI Course Completion Record
for Lawrence Burgess

To whom it may concern:

On *2/18/2005*, *Lawrence Burgess* (username=burgesslpatripler; Employee Number=) completed all *CITI Program* requirements for the *Basic CITI* Course in The Protection of Human Research Subjects.

Learner Institution: *Tripler Army Medical Center*

Learner Group: *Group 1.*

Learner Group Description: *Biomedical Research Investigators and Staff*

Contact Information:

Department: Surgery
Which course do you plan to take?: Biomedical Investigator Course Only
Role in human subjects research: Clinical Reseacher
Mailing Address:
Email: lburgess@hawaii.edu
Office Phone: 8085282938
Home Phone:

The Required Modules for *Group 1.* are:	Date completed
Introduction	02/18/05
History and Ethical Principles	02/18/05
Basic Institutional Review Board (IRB) Regulations and Review Process	02/18/05
Informed Consent	02/18/05
Social and Behavioral Research for Biomedical Researchers	02/18/05
Records-Based Research	02/18/05
Genetic Research in Human Populations	02/18/05
Research With Protected Populations - Vulnerable Subjects: An Overview	02/18/05

Vulnerable Subjects- Research Involving Minors	02/18/05
Vulnerable Subjects- Research Involving Pregnant Women and Fetuses in Utero	02/18/05
Group Harms:Research With Culturally or Medically Vulnerable Groups	02/18/05
FDA-Regulated Research.	02/18/05
Human Subjects Research at the VA	02/18/05
HIPAA and Human Subjects Research	02/18/05
Conflicts of Interest in Research Involving Human Subjects	02/18/05
Tripler Army Medical Center.	02/18/05
Additional optional modules completed:	**Date completed**

For this Completion Report to be valid, the learner listed above must be affiliated with a CITI participating institution. Falsified information and unauthorized use of the CITI course site is unethical, and may be considered scientific misconduct by your institution.

Paul Braunschweiger Ph.D.
Professor, University of Miami
Director Office of Research Education
CITI Course Coordinator

APPENDIX J
Curriculum Vitae

Dale S. Vincent, MD, MPH, FACP

PERSONAL INFORMATION

Date of Birth:	7 November 1953
Place of Birth:	Ft. Belvoir, Virginia
Home Address/Telephone:	154 Pauahilani Place Kailua, HI 96734 808-263-4788
Professional Address:	Telehealth Research Institute MEB-212 651 Ilalo Street Honolulu, HI 96813 808-692-1083 808-692-1250 (fax)
E-mail	dvincent@hawaii.edu
Spouse:	Judy M. Vincent, MD Pediatric Infectious Disease
Children:	Peter Bryan (b. 12/30/86) Andrew Alan (b. 5/31/91) William Russell (b. 5/31/91)

ACADEMIC RANK AND POSITION

Director of Telemedicine, Telehealth Research Institute 2005-
Assistant Clinical Professor of Medicine, University of Hawaii
John A. Burns School of Medicine
Adjunct Associate Professor, Telehealth Research Institute

EDUCATION

Undergraduate: United States Military Academy, West Point, NY	BS	1976
Medical school: University of Texas Southwestern Medical School, Dallas, TX	MD	1980
Residency: Resident in Internal Medicine, Tripler AMC, HI		1980-1983

Fellowship: Fellow in General Internal Medicine Walter Reed AMC, Washington, DC	1987-1989
Graduate School: Uniformed Services University of the Health Sciences, Bethesda, MD	MPH 1989

BOARD CERTIFICATION

American Board of Internal Medicine (Candidate No. 092602)	1983 (Indef)
Geriatric Medicine Subspecialty – American Board of Internal Medicine	2005-2015

MEDICAL LICENSURE AND CERTIFICATIONS

Texas License Number F - 7264	Active
Hawaii License Number MD 13475	Active
Advanced Cardiac Life Support	Aug 05 – Aug 07
Advanced Trauma Life Support	Aug 05 – Aug 09

HONORS/AWARDS

Order of Military Medical Merit, Tripler Army Medical Center	1984
Robert Moser ACP/Army Surgeon General Outstanding Internist Award	1986
Outstanding Fellow, Department of Medicine, Walter Reed AMC	1989
Department of Medicine Staff Teaching Award	1997

MILITARY SERVICE

Tripler Army Medical Center, Honolulu, HI	
Resident and Chief Resident in Internal Medicine	1980-1984
5th General Hospital, Stuttgart, West Germany	
Staff Internist	1984-1985
Chief, Department of Medicine	1985-1987
Walter Reed Army Medical Center, Washington, DC	
Fellow in General Internal Medicine	1987-1989
Tripler Army Medical Center, Tripler AMC, HI	
Chief, General Medicine Service	1989-1991
Associate Program Director	1990-1994
Program Director, Department of Medicine	1994-1997
Assistant Chief, Department of Medicine	1996-1997
Chief, Department of Medicine	1997- 2005
Director, Medical Product Line	1997- 2005
Retired as Colonel with 29 years of active service	2005

MILITARY AWARDS

Army Achievement Medal (4)
Army Commendation Medal (3)
Meritorious Service Medal
Legion of Merit

CIVILIAN

Nekton LLC, Honolulu, Hawaii

PREVIOUS PROFESSIONAL POSITIONS AND APPOINTMENTS

Chief Resident in Internal Medicine, Tripler AMC, HI	1983 - 1984
Clinical Instructor, University of Hawaii	1983-1984
Clinical Instructor, Uniformed Services University Bethesda, MD	1987-1988
Teaching Fellow, Uniformed Services University Bethesda, MD	1988-1989

MEDICAL STUDENT EDUCATIONAL ACTIVITIES SINCE 1990

John A. Burns School of Medicine (University of Hawaii):

Community Medicine Preceptor for MS2 students	1990
Community Medicine Preceptor for MS2 students	1991
Clinical Skills Preceptor for MS1 students	1992–1994
Problem-Based Learning Tutor for MS1 students	1993
Site Coordinator for MS3 Medicine Clerks	1993–1994

INSTITUTIONAL/DEPARTMENTAL AND DIVISION ADMINISTRATIVE RESPONSIBILITIES, COMMITTEE MEMBERSHIPS, AND OTHER ACTIVITIES

Chair, Infection Control Committee, 5th General Hospital	1985-1987
Chair, Community Health Education Program Greater Stuttgart Military Community	1986-1987
Chair, Tripler Drug Usage Evaluation Committee	1989-1990
Chair, Ambulatory Patient Care Assessment Subcommittee	1989-1994
Chair, Department of Medicine Education Committee Tripler AMC	1990-1997
Chair, Composite Health Care System Ward Implementation Team	1991-1992

Member, University of Hawaii Department of Medicine Student Evaluation Committee	1992-1996
Chair, OB-GYN Patient Access Process Action Team	1993-1994
Member, Primary Care Initiative, Tripler AMC	1993-1997
Member, University of Hawaii John A. Burns School of Medicine Working Party on Distance Learning	1993-1995
Chair, Clinical Consultant Committee, PACMEDNET	1996-1998
Member, Tripler Functional Management Team for Informatics and Technology	1996-1998
Member, Tripler Functional Management Team for Organization Ethics	1997-2000
Chair, Tripler Functional Management Team for Care of Patients	1997-2003
Co-Chair, Tripler Army Medical Center Patient Safety Committee	2002-2003
Chair, Tripler Army Medical Center Patient Safety and Medication Management Functional Management Team	2003-2005

PROFESSIONAL MEMBERSHIPS AND SOCIETIES

Member, Society of General Internal Medicine	1988-1995
Member, American College of Physicians	1984-1994
Member, Student Affairs Committee, Hawaii ACP Chapter	1992-1994
Member, Association of Program Directors in Internal Medicine	1994-2002
Fellow, American College of Physicians (#061638)	1994-
American Geriatrics Society	2004-

GRANTS

Thailand-Hawaii Assessment of Interactive Healthcare Initiative (THAI-HI). Pacific e-Health Innovation Center, $591,000. July 2000 – June 2002.

Project THAI-HI. Freeman Foundation, Honolulu, Hawaii. $438,000, October 2002 – September 2004.

Interactive Nursing Skills Training Applying Advanced Networked Technology. Pacific Telehealth and Technology Hui, Honolulu, Hawaii. $80,000. October 2002 – October 2003.

Comprehensive Diabetes Management Program Multicenter Trial, $200,00. Medical Research and Materiel Command, University of Hawaii, and Pacific Telehealth and Technology Hui. 2003 - 2005.

Interactive Nursing Skills Training Applying Advanced Networked Technology II. Pacific Telehealth and Technology Hui, Honolulu, Hawaii. $100,000. November 2003 to present.

GRIDIRON I and II: Access Grid Internet2 Research with Overseas Networks. Pacific Telehealth and Technology Hui, Honolulu, Hawaii. 2003 – 2005.

PRESENTATIONS AT NATIONAL MEETINGS

Kroenke K and DS Vincent. Attending Rounds: Obstacles and Opportunities. Workshop presented at the National Meeting of the Society of General Internal Medicine, Seattle, WA, 3 May 1991.

Medical Education over Internet2. Research in Minority Institutions Conference, Honolulu, Hawaii. Feb 9, 2003.

PRESENTATIONS AT REGIONAL MEETINGS

Vincent D and J Fruendt. Making Morning Report Interactive. Workshop presented at the Regional Meeting of the American College of Physicians, San Francisco, CA, October 1991.

Vincent D. Ambulatory Medicine: A Panel Discussion. Panel organizer and moderator at the Regional Meeting of the American College of Physicians, San Francisco, CA, October 1991.

Vincent DS and J Fruendt. Teaching Quality Improvement in the Ambulatory Setting. Workshop presented at the 9th Annual Army/ACP Regional Meeting, San Francisco, CA, 7 November 1992.

Vincent DS. "Saturday Night Smoker: Internal Medicine versus Geriatrics." Plenary speaker at the 9th Annual Army/ACP Regional Meeting, San Francisco, CA, 7 November 1992.

Faran D and DS Vincent. Successful oral treatment of symptomatic lead poisoning in two marine entrepreneurs (Abstract). Presented at the Regional Meeting of the Hawaii Chapter of the ACP, Honolulu, HI, 12 March 1993.

Vincent D. Large Group PBL. Workshop presented at John A. Burns School of Medicine Problem Based Learning Workshop, 14 September 1993.

Vincent D and D Faran. Teaching Interns How to Become Effective Junior Residents. Workshop presented at the 10th Annual Army/ACP Regional Meeting, Orlando, FL, 20 November 1993.

Vincent D. Telephone Medicine. Workshop presented at the 10th Annual Army/ACP Regional Meeting, Orlando, FL, 20 November 1993.

Vincent D. Kitten scratch disease and problem-based learning. Workshop presented at the Hawaii Consortium for Continuing Medical Education, Honolulu, Hawaii, 21 December 1993.

Vincent D and B Cuneo. InfoBahn or InfoYawn: Establishing a Resident Learning Center that Works. Workshop presented at the 11th Annual Army/ACP Regional Meeting, Reston, VA, 27 October 1994.

Vincent D, D Faran, and B Berg. Starting from Scratch: Reinviting a Residency Program. Workshop presented at the 11th Annual Army/ACP Regional Meeting, Reston, VA, 30 October 1994.

Vincent D. Typhoid Fever and Problem Based Learning. Workshop presented at the Tutor Training Seminar of the John A. Burns School of Medicine, Shriner's Hospital, Honolulu, HI, 20 September 1994.

Vincent, D. Stroke in a Young Woman and Problem Based Learning. Workshop presented at the Tutor Training Seminar of the John A. Burns School of Medicine, Shriner’s Hospital, Honolulu, HI, September 1995.

Vincent, D and B Cuneo. How to Create an Internet Home Page in Less than 8 Minutes. Workshop presented at the 12th Annual Army/ACP Regional Meeting, Reston, VA, October 1995.

Vincent, D and W Reed. To Go Forward You Must Retreat: Conducting an Organizational Retreat. Workshop presented at the 12th Annual Present Concepts in Internal Medicine ACP Meeting, Reston, VA, 31 October 1996.

Cary-Freitas, B and D Vincent. An Interesting Model of Disseminating Military Medical Education. Abstract presented at the 14th Annual Present Concepts in Internal Medicine ACP Meeting, Reston, VA, 21 November 1998.

Vincent, D and A McCowen. Reducing Medical Errors through Statistical Process Control. Presented to the 16th Annual Present Concepts in Internal Medicine ACP Meeting, Reston, VA, 19 November 2000.

Vincent D. INSTAANT: Interactive Nursing Skills Training Applying Advanced Network Technology. American Association of Healthcare Executives. Honolulu, Hawaii. 12 September 2003.

Vincent D, Berg B. International Military Medical Education. Presented to the 19th Annual Present Concepts in Internal Medicine ACP Meeting, San Antonio, TX, 7 November 2003.

PRESENTATIONS AT INTERNATIONAL MEETINGS

Prevention of Osteoporosis in Patients on Chronic Steroid Therapy.
Current Therapy of Inflammatory Bowel Disease.
Meta-Analysis: An Overview.
Dealing with Uncertainty in Patients with Chronic Renal Disease.
4 Lectures presented at the 39th Annual Medical Surgical Symposium, Willingen, Germany, April 17-21, 1994.

Thailand-Hawaii Assessment of Interactive Healthcare Initiative. Presented at the 11th Annual Asia-Pacific Military Medicine Conference, Auckland, NZ, May 8, 2001.

Internet2 and the Next Generation Internet. Presented at the 12th Annual Asia-Pacific Military Medicine Conference, Kuala Lumpur, Malaysia, April 24, 2002.

International Medical Education using Internet2. Podium presentation at the 2nd Annual Australian Defence Health Symposium. Sydney, Australia, July 28, 2002.

International Medical Education using High-Bandwidth Internet: Transition from ISDN to Internet2. Presentation at the 2nd Successes and Failures in Telehealth Conference, Brisbane, Australia, August 2002.

Comparison of ISDN and Internet2 in Project THAI-HI. Presented at the 13th Annual Asia-Pacific Military Medicine Conference, Bangkok, Thailand, May 10, 2003.

INSTAANT: Interactive Nursing Skills Training Applying Advanced Networked Technology. Presentation at the 3rd Successes and Failures in Telehealth Conference, Brisbane, Australia, August 23, 2003.

International Medical Education between Hawaii and Thailand over Internet2. Presentation at 3rd Successes and Failures in Telehealth Conference, Brisbane, Australia, August 22, 2003 [abstract presented by D Hudson].

Complimentary and Alternative Medicine at a US Army Hospital. Vietnam-US Military Medical Exchange, Military Academy of Medicine, Hanoi, Viet Nam, March 10, 2002.

Simulation in Medical Education. Presented at the 16th Annual Asia-Pacific Military Medicine Conference, New Delhi, India, March 27, 2006.

Telemedicine 2006. Primary Care and Preventive Medicine Seminar. Colonial War Memorial Hospital, Suva, Fiji, June 23, 2006.

INTRAMURAL PRESENTATIONS

Vincent, DS. Attending Rounds: Obstacles and Opportunities. Workshop presented to departmental faculty at Tripler AMC, HI, 15 February 1991.

Vincent DS and J Fruendt. "Teaching Quality Improvement in the Ambulatory Setting." Medical Grand Rounds presented at Tripler AMC, HI, 29 October 1992.

Vincent DS and D Faran. "Diabetic Amotrophy and Alternative Teaching Strategies." Medical Grand Rounds presented at the University of Hawaii Integrated Medical Residency, Honolulu, Hawaii, 15 March 1994.

Vincent D and JC Holland. Alternative Medicine. Hospital Brown Bag Ethics Seminar, Tripler AMC, HI, 2 September 1997.

Vincent D. Hypertension in Women. Lecture presented to Department of Obstetrics-Gynecology, Tripler AMC, HI, 12 December 1997.

Vincent D. Ethics in Managed Care. Hospital Ethics Seminar, Tripler AMC, HI, 6 March 1998.

Vincent D, C Holland, and J Pina. Withholding and Withdrawing Care. Hospital Ethics Seminar, Tripler AMC, HI, 24 July 1998.

Vincent, D. Hypertension update. Presented to the Department of Medicine, Tripler AMC, HI, 30 Sep 1998.

Vincent, D. Global Burden of TB. Presented to 2nd Annual Tripler Tuberculosis Symposium, Tripler AMC, HI, 4 Nov 1999.

Vincent, D. Global Burden of TB. Presented to the 3rd Annual Tripler Tuberculosis Symposium, Tripler AMC, HI, 19 Jan 2001.

Vincent, D. Simulation in Medical Education. John A. Burns School of Medicine, HI, March 29, 2006.

EXTRAMURAL PRESENTATIONS

Kitten Scratch Disease. Medical Grand Rounds presented at Hawaii Permanente Medical Center, 16 August 1994.

Inpatient Geriatric Assessment. Invited Presentation at the Pacific Geriatric Education Center, University of Hawaii School of Public Health, 18 October 1994.

Urinary Incontinence. Tripler Army Medical Center, HI, February 14, 2006

RESEARCH INTEREST

Measuring outcomes of educational interventions

CIVIC ACTIVITIES

Chairman, Lanikai Charter School Board of Directors, 1996 - 2001
2001 Winner of the Malcolm Baldrige Hawaii State Award of Excellence for Education

Member, Board of Directors, Windward Senior Daycare Center, Kailua, HI 1999-2003

BIBLIOGRAPHY

Publications - Journals

Vincent DS, Cooper GS, Harvey J, Noel GL. Assessing medical student interviews of HIV patients: a randomized trial of a simple intervention. Proceedings of the twenty-seventh annual conference. Chicago: Association of American Medical Colleges, 1988.

Enzenauer R, McKoy J, Vincent DS and Gates R. Disseminated cutaneous and synovial mycobacterium marinum infection in a patient with systemic lupus erythematosis. South Med J. 1990 Apr; 83(4): 471-4.

Vincent DS, Berg BW, Hudson D, Suwicha T. Thailand-Hawaii Assessment of Interactive Healthcare Initiative. Journal of Telemedicine and Telecare, 2003, 9(3).

Vincent D. Complimentary and Alternative Medicine at a U.S. Army Hospital in Hawaii. Journal of Military Pharmaco-medicine. Hanoi: 2003, March 2003: 202-204.

Vincent DS, Berg B, Hudson D. Interactive Nursing Skills Training Applying Advanced Network Technology (INSTAANT). Journal of Telemedicine and Telecare. 2003, 9(suppl 2): 68-70.

Vincent DS, Berg BW, Suwicha C, Burgess L, Hudson D. International Medical Education between Hawaii and Thailand over Internet2. Journal of Telemedicine and Telecare. 2003, 9(suppl 2): 71-72.

Berg BW, Vincent DS, Hudson DA. Remote Critical Care Consultation: Telehealth Projection of Clinical Specialty Expertise. Journal of Telemedicine and Telecare. 2003, 9(suppl 2): 9-11.

Soh EK, Vincent DS, Berg BW, Chitpatima ST, Hudson DH. An international landmine telehealth symposium between Hawaii and Thailand using an Internet2 and multi-protocol videoconferencing bridge. Hawaii Med J. 2004 Oct; 63(10):294-5.

PUBLICATIONS – ABSTRACTS

Vincent DS, Cooper GS, Jeffers DJ. A match made in heaven: introduction of meta-analysis to a journal club (Abstract). Clin Res. 1989; 37(2): 816A. Presented at the annual meeting of the Mid-Atlantic Society of General Internal Medicine, February 26, 1989, Baltimore, MD.

Vincent, DS, Cooper GL, Birdwell BB, Noel GL. Raters of a lost art: how attending physicians rate a case presentation (Abstract). Clin Res. 1989; 37(2): 815A. Presented at the annual meeting of the Mid-Atlantic Society of General Internal Medicine, February 26, 1989, Baltimore, MD.

Cooper G, Vincent DS, Harvey J, Hendrix RM, Noel GL. A study of infection control training needs of medical students (Letter). Am J Infect Control. 1990 Apr; 18(2): 126-7.

Vincent DS. Do medical students interview HIV patients differently than lymphoma patients? (Abstract). Presented at the Fifth Biennial Symposium for Teaching Internal Medicine, Boston, MA, November 1989.

Vincent DS. A controlled trial of feedback and role-playing in teaching medical students (Abstract). Presented at the Fifth Biennial Symposium for Teaching Internal Medicine, Boston, MA, November 1989.

APPENDIX K

UNIVERSITY OF HAWAIʻI

HONOLULU, HAWAIʻI

THIS IS TO CERTIFY THAT

Dale Vincent

HAS COMPLETED THE UNIVERSITY OF HAWAIʻI'S FOUR HOUR WORKSHOP ON

**"THE PROTECTION OF HUMAN RESEARCH SUBJECTS
FOR
RESEARCH INVESTIGATORS"**

William H. Dendle
Executive Secretary / Compliance Officer
Committee on Human Studies
University of Hawaiʻi

Date of workshop: February 10, 2006

kathleen Kihmm Connolly

From:	Duchesneau, Caryn L Ms USAMRMC [Caryn.Duchesneau@us.army.mil]
Sent:	Monday, February 19, 2007 4:48 PM
To:	lburgess@hawaii.edu
Cc:	Wells, Lisa L. Ms USAMRAA; Saiki, Stanley Dr Hui TAMC; Brosch, Laura R COL USAMRMC; Duchesneau, Caryn L Ms USAMRMC; Bennett, Jodi H Ms USAMRMC; Pascal, Louise M Ms AMDEX; Odam, Kimberly L Ms AMDEX; kihmm@hawaii.edu
Subject:	A-14006, Approval Memo (Proposal Log Number 06083002, Award Number W81XWH-07-2-0002)

SUBJECT: Protocol, "SimCenterHawaii Technology Enabled Learning and Intervention Systems," Submitted by Lawrence P. Burgess, M.D., Telehealth Research Institute, Honolulu, Hawaii, Proposal Log Number 06083002, Award Number W81XWH-07-2-0002, HRPO Log Number A-14006

1. The subject protocol, informed consent forms, and study related documents dated 25 January 2007 have been reviewed and found to comply with applicable Federal, DOD, U.S. Army, and U.S. Army Medical Research and Materiel Command (USAMRMC) human subjects protection regulations.
Documentation of approval by the University of Hawaii Committee on Human Studies (CHS) was received on 14 November 2006, 18 January 2007, and 14 February 2007.

2. This no greater than minimal risk study is approved for the enrollment of up to 25 subjects in Phase I and up to 5 subjects as usability evaluators and up to 5 subjects as first responders (users) in Phase II.

3. Please note the following reporting obligations:

a. Major modifications to the research protocol and any modifications that could potentially increase risk to subjects must be submitted to the USAMRMC Office of Research Protections, Human Research Protections Office (ORP HRPO) for approval prior to implementation. All other amendments must be submitted to the ORP HRPO for acceptance with the continuing review report.

b. All unanticipated problems involving risks to subjects or others, serious adverse events related to study participation, and deaths related to study participation must be reported promptly to the ORP HRPO.

c. Any deviation to the subject protocol that affects the safety or rights of the subject and/or integrity of the study data must be reported promptly to the ORP HRPO.

d. All modifications, deviations, unanticipated problems, adverse events, and deaths must also be reported at the time of continuing review of the protocol.

e. A copy of the continuing review report approved by the University of Hawaii CHS should be submitted to the ORP HRPO as soon as possible after receipt of approval. It appears that the next continuing review is due no later than 25 August 2007.

f. In addition, the current version of the protocol and consent form should be submitted along with the continuing review report and the University of Hawaii CHS approval notice for continuation of the protocol.

g. When available, the final study report submitted to University of Hawaii CHS, including a copy of any acknowledgement documentation and any supporting documents, must be submitted to the ORP.

4. The ORP HRPO point of contact for this study is Kimberly Odam M.S., C.C.R.P., Human Subjects Protection Scientist at 301-619-8039.

CARYN L. DUCHESNEAU, CIP
Chief, Human Subjects Protection Review
Human Research Protection Office
Office of Research Protections
U.S. Army Medical Research and Materiel Command

Note: The official copy of this approval is housed with the protocol file at the Office of Research Protections, Human Research Protections Office, 504 Scott Street, Fort Detrick, MD 21702. Signed copies will be provided upon request.

Note: Do not construe this correspondence as approval for any contract funding. Only the Contracting Officer or Grants Officer can authorize expenditure of funds. It is recommended that you contact the appropriate contract specialist or contracting officer regarding the expenditure of funds.

Appendix F
Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders

Mass Casualty Triage Training using Human Patient Simulators Improves Speed and Accuracy of First Responders

Abstract.

Medical triage in mass casualty or trauma events is an area where rapid, accurate decision-making is vital for achieving positive outcomes. It is necessary that first responders and medical personnel are thoroughly trained and prepared for action; however, there are few opportunities to obtain the training and experience necessary for optimal performance in mass casualty emergency situations. We hypothesized that successive exposure of first responder trainees to a series of mass casualty triage scenarios using manikins would result in improvements in triage speed and accuracy, and that these same iterative training exposures will result in a measurable change in self-efficacy, and a measurable positive correlation between self-efficacy ratings to actual performance. Twenty-one First Responders were trained using a podcast-based triage course, followed by hands on exposure to three successive manikin based scenarios of five simulated patients each. Students demonstrated greater speed and accuracy after triaging ten simulated casualties, but no additional improvement was noted after five additional simulated casualties. Self-efficacy remained unchanged during the exercise. Principles of Mass Casualty Triage can be effectively taught to First Responders using a combination of podcasts and hands on experience with manikins. Beyond exposure to ten simulated casualties, learner performance remained stable.

Introduction.

Medical triage in mass casualty or trauma events is an area where decision-making is vital for achieving positive outcomes. At a disaster site, triage may be the most important medical task performed (Waeckerle 1991). It is vital that first responders and medical personnel are thoroughly trained and prepared for action; however, there are few opportunities to obtain the training and experience necessary for optimal performance in mass casualty emergency situations. Moreover, the Federation of American Scientists (FAS) report in 2003, Training Technology Against Terror: Using Advanced Technology to Prepare America's Emergency Medical Personnel and First Responders for a Weapon of Mass Destruction Attack (Kelly 2002) found that the U.S.' need for first responder training was dramatically larger than previously recognized. There are over 150,000 emergency medical technicians and 1.7 million firefighters in the U.S. who would be expected to use complex critical thinking skills, such as triage, as part of incident management teams. Simulation technology can provide a solution for the need to train triage by providing readily available cognitive and procedural training platforms that can supplement a didactic triage curriculum. In addition to skills training, simulation exercises can help lower psychological barriers in stressful emergency situations by providing a safe controlled environment for practice. Similar to the value of flight simulators for pilots, medical simulators permit both physical and mental skills development and maintenance for health care providers. Another advantage of simulation is the availability for longitudinal training. It has been shown that learned skills, such as cardiopulmonary resuscitation (CPR) can deteriorate as early as two weeks after training, both in lay persons and in medical personnel (Wright 1989, Kaye 1986)) with skills equaling pre-assessment baseline at 6-months for physicians and nurses (Gass 1983). Frequent retraining is essential for infrequently performed procedures like CPR. Simulation training can provide an opportunity to train and retrain so skills can be maintained.

Manikin training with computerized life-size manikins provides realism, as diagnostic assessments and therapeutic interventions must be manually performed, in addition to cognitive decision making. As such, training on manikins may be more relevant for untrained learners as medical or allied health students. However, even for trained and practicing providers, manikin scenarios serve as excellent methods to assess competency for course completion or certification. In summary, manikins can be utilized in triage training for several purposes: a) initial and subsequent training for both procedural and decision-making skills, and b) competency assessment of both procedural and decision-making triage skills.

Manikin based simulations have been mainstays in medical education for many years. Less advanced manikins are utilized in certification courses like Basic Life Support (BLS). Simulators are recognized by the Accreditation Council of Graduate Medical Education (ACGME) as a valid method in assessing clinical competency (ACGME 2000). The application of advanced computer technology with anatomic, physiologic, and pharmacologic realism has increased the applicability for manikins to provide advanced simulation training in many areas of acute care medicine.

Physicians have traditionally depended on bedside teaching to impart knowledge to trainees. This concept has become less popular because of concern over patient safety, as well as it being difficult to have a representative patient available for each diagnosis. The ethical imperative to use simulation in training whenever possible is an important concept, as patients are protected instead of being commodities in training. (Ziv 2003). As such, simulation training provides an important and well-recognized bridge between the textbook and the bedside.

Advanced manikin simulators have found acceptance by students in education for both medicine (Weller 2004) nursing (Bearnson 2005, Nehring 2004). Applying manikin simulation training to existing curricula has also demonstrated value (Gaiser 2000, Howard 1992).

Acquisition of Triage Skills Model

To assess the impact of manikin training on learning, a previously validated model will be utilized (DeVita 2005). In this model, all learners had initial web-based didactic training, followed by live didactics. This included video and live familiarization with the manikin. Disease conditions and a set of 29 specific skills to be acquired were described during didactics, as well as video demonstrations of how to perform these actions. These 29 skills were replicated in each of 5 different cased-based scenarios. Trainees were randomized to receive 3 of the 5 scenarios, so there were no repeats of scenarios for learners. After didactics, the first assessment was made on the manikin, and the number of skills performed correctly were recorded, as well as whether the manikin survived. A second and third assessment was also accomplished, and the differences in outcomes between the 3 different assessments was made. They demonstrated that didactic training alone for Acute Cardiac Life Support training was not adequate for trainees to demonstrate performance of these skills on the manikin, as skill acquisition and manikin survival was significantly lower on the first assessment than after the second and third assessments. This also indicated that training on the manikin resulted in improved skills acquisition and manikin survivability.

Self-efficacy in Triage

Possessing the knowledge and skill to perform triage alone may not be adequate. The knowledge and skills have to also accompany the personal beliefs of efficacy to meet the demands of the situation. Self-efficacy, one’s judgment of one’s capabilities to successfully perform a task, has been shown to influence one’s performance. Persons with the same knowledge and skills may perform poorly or exceptionally, depending on fluctuations in self-efficacy (whether they are thinking in a enabling or debilitating manner) (Bandura 1993). Studies have documented that medical training can result in increased self-confidence in dealing with medical situations. Levels of self-efficacy have been able to predict performance in objective structured clinical examinations (Mavis 2001). There is no evidence of efficacy studies in the evaluation of student’s perceptions on manikin-based learning environments. It is hypothesized that there is a positive association between self-efficacy rating on knowledge and performance to actual performance.

In this study, students will receive didactic training, followed by sequential manikin training and assessment. We expect both types of training will affect self-efficacy ratings. The self-efficacy ratings after the didactic training will act as a baseline. After the first manikin training self-efficacy may be affected by how well the student performs, either increase if the manikin performance was well done, or decrease if the student has trouble. After the third manikin training, we expect that self-efficacy ratings will again increase or decrease in correlation with the manikin training performance. However, we do expect that there is a correlation between the amount of training received and self-efficacy; the greater amount of hand-on experience in triage, the greater amount of confidence, resulting in higher self-efficacy ratings.

Methods.

Setting. Medical school simulation laboratory.

Design. Orientation instructions, scenarios, and measurement instruments were tested and refined before the study. After the scenarios were determined to be understandable, 21 subjects were recruited and signed informed consent. Subjects first took an ungraded 20-question pre-test to prepare them for the subsequent didactic material. Subjects then downloaded and listened to four instructional podcasts (total of 19:35 minutes): 1) Introduction to Manikin Simulation (3:57 minutes), 2) Triage Basics (4:53 minutes), 3) Triage Challenge I (5:00 minutes), and 4) Triage Challenge II 5:45 minutes). Subjects then took a 20-question posttest. A score of equal or greater than 85% was required for inclusion in the triage exercise with manikins. The manikin setups were performed by one simulation specialist, and the orientation and debriefing sessions were conducted by the same physician.

Self-efficacy. Subjects completed a self-efficacy questionnaire before manikin training, after first manikin training scenario, and after the final manikin training experience. After students have completed the post-test, they will be instructed to complete two brief questionnaires, a Reaction Questionnaire (RQ) and a Learning Environment Questionnaire (LEQ). The RQ is an instrument that has been previously used to assess learner satisfaction with web-based training material. The questionnaire is designed to assess the relevance of the training to the learner's perceived "role as a first responder" rather than to the learner's usual clinical role. Two validated subscales of the LEQ (the Self-Efficacy Scale (3 questions), and the Patient-Physician Relationship Scale (2 questions)) were administered. Each question was scored on a 4-point Likert scale with points labeled "Never" (1), "Occasionally" (2), "Frequently" (3), and "Always" (4).

Scenarios. Three groups of five manikins represented simulated casualties. Each group consisted of 3 "immediate," 1 "minimal", and 1 "delayed" or "expectant" simulated casualties. Each group included these "immediate" injuries: one hemorrhagic shock, one tension pneumothorax, and one airway management problem. "Delayed" casualties included a patient with a leg fracture, and a patient with blunt abdominal trauma. The "expectant" casualty had massive head trauma. "Minimal" patients had minor wounds with normal vital signs. Subjects were required to identify the main abnormality, perform an intervention, and tag each casualty correctly. Main abnormalities fell into these categories: airway, breathing, circulation, neurologic, and other. Intervention options included applying a tourniquet, using a HemCon bandage, performing a needle decompression, and inserting a nasopharyngeal airway. In some instances, "no intervention" was the appropriate response.

Statistical analysis. Times were compared between the three scenarios using one-way ANOVA for each student. Frequency of correct interventions and tags were compared between the three scenarios (range 0 to 5 correct interventions or tags per scenario) using one-way ANOVA for each student. Frequency of correct main abnormalities and required intervention (range 0 to 15 correct abnormalities and interventions per scenario) were compared using one-way ANOVA for each student. Self-efficacy was analyzing by summing the 5-point Likert responses for five self-efficacy questions and comparing the totals between scenarios using chi-square analysis. Post-hoc analysis was performed using the method of Scheffe.

The design is a repeated measures analysis of task completion (yes or no) between Scenario #1 and Scenario #2, with a difference of 30% being investigated. This difference is based on Devita's previous research,6 which demonstrated that task completion due to the effect of training was improved most between training sessions #1 and #2. For that given effect size, a sample size of 20 is needed (alpha=0.05, 2-tailed, power=0.8).

Results.

Demographics. 20 out of 21 (95%) students achieved a score of > or = 85% on the examination, and were included in the study. Most students were in their 2nd year of Medical School (12/20 (55%), but there was participation by 4 MS3 (20%), 4 MS4 (20%), and 1 MS1 (5%) (see Table 1).

Precourse ratings. Students rated the podcast-based precourse highly (6.39 on 7-point Likert scale). They felt that the pace was just about right (4.5 on a 7-point Likert scale, 1=too slow, 7=too fast). The pace was also just right (4.0, 1=too easy, 7=too hard).

Self-confidence. Students expressed uncertainty in their triage skills at the outset of the exercise (3.53 on a 5-point Likert scale, 1=never to 5=always confident). Confidence improved after the exercise began and the first five patients were triaged (3.67), and sustained an additional increase after 15 patients had been triaged (4.23). This increase was not statistically significant ($p = 0.101$).

Tagging performance. Tagging performance improved significantly during the exercise ($p < 0.0001$) Student performance was low during the first iteration of five patients. On average, tags were completely correct only 1.7 out of 5 times (34%). When counting the total number of items on each tag, the group of 20 students correctly tagged the first 100 patients only 177 out of 300 times (59%). However, after the next five patients were triaged, 3.3 tags (66%) were completely correct on average. When counting the total number of correct items on each tag, the group of 20 students correctly tagged the second 100 patients 251 times out of a possible 300 (84%). Tagging performance was statistically signifiant between the first and second scenarios ($p<0.0001$), but not between the second and third scenarios (p=xxx). Performance continued to improve during the last iteration of five patients, but not as much. After the last five patients were triaged, 3.6 tags (72%) were completely correct on average. When counting the total number of correct items on each tag, the group of 20 students correctly tagged the last 100 patients 256 times out of a possible 300 items (85%).

Intervention performance. Intervention performance improved significantly during the exercise ($p < 0.0001$). Average number of correct interventions per learner was 3.1 (62%) for the first five patients. This increased to 4.4 (88%) after the next five patients, and increased a small amount after the last iteration of five patients to 4.5 (91%), an overall relative increase of 32%. The improvement in performance was statistically significant between the first and second scenarios ($p<0.0001$) but not between the second and third scenarios (p=XXX).

Time to triage. The time to triage five patients improved significantly ($p < 0.0001$) during the each iteration of five patients. The average time for the first group of patients was 8:26, improving to 6:19 (33.5% better) for the second group, and 5:40 for the last group (further 11.4% reduction). The overall relative improvement was 45%. The improvement in time was statistically significant between the first and second scenarios ($p<0.0001$), but not between the second and third scenarios (p=xxx).

Summary. Tagging and intervention performance improved significantly after the second iteration of patients. Self-confidence improved significantly between 5 and 15 patients triaged. Time continued to improve with more practice through each group of five patients. Thus, efficiency was dramatically improved.

Course evaluation. The students rated the course highly (6.83 on 7-point Likert scale). The pace was just right (4.2 on 7-point Likert scale, 1=too slow and 7=too fast). The level of difficulty was also good (4.05 on 7-point Likert scale, 1=too easy and 7=too hard). The students also agreed that the course was relevant to them as healthcare providers (6.75 on 7-point Likert scale).

Discussion.

In this study, we demonstrated that novice First Responders were able to demonstrate the successful acquisition of mass casualty triage skills after two successive iterations of hands-on exposure and directed feedback. The learners improved significantly in their ability to correctly tag the patients and intervene appropriately. Furthermore, in addition to demonstrating improved accuracy, the learners worked significantly faster. Of importance to educators, the addition of a third scenario consisting of five more simulated patients to triage reliability improve the learner's speed or accuracy. This finding has implications for planners and course directors, since the training time can be shortened by approximately one-third.

There are several limitations to this study. The abnormalities that were simulated, and the order of the simulations, was fixed for each scenario rather than being randomly assigned. This was done for practical reasons to ensure the quick setup and turnover of the simulations between scenarios. Although most of the students had previous experience working with manikins in other courses, we cannot exclude that at least some of their improvement may have been due to increasing familiarity with the capabilities of the manikins. The fidelity of our simulations was moderate; we did not create simulated wounds on the manikins, but relied on torn, painted clothing to simulate injuries. This required the learners to use inference during their assessments. This did not appear to be a barrier to learning. Instead, it seemed to alllow the instructor to focus on the teaching points without being distracted by moulage. This also enabled the rapid turnover of manikins for the next scenario.

This technique of using manikins to measure when learners stop improving during the acquisition of skills may have broader implications for the simulation community. Simulations can be labor intensive and time consuming. Being able to reliably determine that there is limited value in continuing an exercise beyond a certain number of practice sessions has the potential of conserving valuable faculty, student, and simulation center resources.

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Appendix G
Design and Development of a Pose-Based Command Language for Triage Training in Virtual Reality

Design and Development of a Pose-Based Command Language for Triage Training in Virtual Reality

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ABSTRACT

Triage is a medical term that describes the process of prioritizing and delivering care to multiple casualties within a short time frame. Because of the inherent limitations of traditional methods of teaching triage, such as paper-based scenarios and the use of actors as standardized patients, computer-based simulations and virtual reality (VR) scenarios are being advocated.

We present our system for VR triage, focusing on design and development of a pose and gesture based interface that allows a learner to navigate in a virtual space among multiple simulated casualties. The learner is also able to manipulate virtual instruments effectively in order to complete required training tasks.

Keywords: Medical VR, pose and gesture based interface.

Index Terms: J.3 [Computer Applications]: Life and Medical Sciences—Medical information systems H.5.1 [Information Systems]: Information Interfaces and Presentation—Artificial, augmented, and virtual realities H.5.2 [Information Systems]: Information Interfaces and Presentation—User InterfacesInput devices and strategies

1 INTRODUCTION

Virtual reality is becoming an important means of computer-aided learning and training. This is particularly the case where real life training is unavailable, unsafe or expensive (see [1] for a survey). More recent examples include treatment of variety of psychological disorders [2, 3, 4] and military training [5].

In most such applications, it is vital to represent the environment to approximate the reality as closely as possible. If the VR system does not allow subjects to believably view and interact with the virtual world, the system is perceived to be deficient. We'll focus on immersive systems where subjects have a life-like experience by interacting with objects that appear life-size in 3D.

Limited field of view of most head mounted displays (HMD) results in a 'tunnel vision' effect, which is one aspect of VR experience people complain about most. Although some recent HMD models provide viewing angle up to 180 degrees [6], their cost together with the need for cluster rendering make such systems prohibitively expensive for many prospective audiences. Another HMD with a wide field of view of 160 degrees [7] exists as a prototype and is not yet available commercially. Besides the high cost, panoramic HMDs are usually bulky and may not be suitable for active VR experiences.

In addition to limited viewing, immersed VR users are also restricted in their ability to interact with the environment. Typically, actions are mapped to a number of tools or metaphors, such as 'virtual hand' for selecting and grasping, 'flying carpet' for travel and more [8].

Limitations of the display systems and interfaces for interaction inevitably distance VR users from the environment. We propose to 'turn the tables' and take advantage of inherent VR shortcomings, by applying VR technology to a task where distancing is actually required in the real life situation. This task is triage training.

In this work, we present a working prototype of a system for training triage skills in virtual reality. We formulate the design principles and give full details on development of the posed-based command language that answers the specific needs of such task. Special attention will be given to travel and object manipulation techniques, essential for successful training. We also discuss results of the first exteriments conducted with our system.

2 TRIAGE, REAL AND VIRTUAL

In triage, a medic must assess and evaluate conditions of multiple victims quickly and set priorities in providing immediate care. Triage skills are necessary in events with great numbers of injured such as disasters or in a battle field where care resources are overwhelmed. The environment is often dangerous, with poisonous gases, dust, debris and even active hostilities present. Therefore, the person doing triage is required to wear protective gear such as gas mask, rubber doff hood or chemical suit, mitten-type gloves, even helmets and body armor.

Triage training is particularly difficult to accomplish when it is required to mimic such a contaminated and hostile environment. Protective suits are expensive and may be in short supply. However, training is important because effectiveness may depend on practical experience. Trainees who don protective equipment have limited fields of vision, limited tactile sensation due to the wearing of gloves, claustrophobia from breathing through respirators and limited mobility due to armor and other safety precautions. Training in protective gear is fatiguing, and the use of instruments through protective gloves is difficult.

VR systems with head mounted displays also have limited fields of vision and can generate claustrophobia. The need to use joystick or gloves limit tactile sensation. The use of an HMD generates fatigue and is cumbersome. Both 'real training' using isolation gear and 'virtual training' using VR equipment, impose similar limitations, thus, the differences between real world experience and VR are narrowed. As real-life triage training already distances trainees

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from the environment with practically the same restrictions that virtual reality impose on the subjects, triage is particularly well suited for implementation in VR.

Moreover, we argue that VR training scenario has a number of important advantages over traditional methods. By eliminating the need to use real human actors and build real physical sets, VR triage

- may reduce the cost of training;
- removes restrictions on age and medical conditions of the simulated victims, which allows to include previously unavailable types of casualties into training scenario: children, pregnant women, people with broken or missing limbs, open wounds, fatalities, etc;
- allows us to put trainees into virtual settings anywhere on Earth, including extreme environments [1].
- allows trainees to administer medications to victims and see the immediate results;
- gives instructors means to measure and evaluate trainee's performance much more accurately than in real-life training;
- makes it possible to train personnel 24 hours a day, 7 days a week, on an individual basis, by having fewer human resource contraints.

We plan to simulate a triage scenario in a toxic environment, in which the user would have to wear a NATO standard biodefense mask, suit, and mittens. This use of actual biodefense equipment makes it unlikely that vision-based tracking and glove-type devices would be useful for building a reliable interface for travel and tool manipulation. Use of a joystick or a game controller would also be problematic while wearing mittens. Yet in a scenario with multiple casualties, travel between victims is essential to accomplishing the triage mission, and virtual instruments must be able to be accessed and applied with some precision. What kind of user interface can provide adequate controls for such task?

3 Related Work

A variety of human-computer interfaces have been utilized in simulated patient scenarios, covering the whole range from desktop systems to fully immersed simulators. The following brief survey is loosely based upon the types of technology involved in the VR systems.

Hubal et al [9] and Kizakevich et al [10] developed virtual patient simulators with single and multiple casualty scenarios; in 2005, they presented a triage teaching program based on an active physiologic model [11]. These applications are non-immersive and utilize a mouse-and-keyboard interface.

A combination of a mouse-based interface and 3D menus was used in *VER*, Virtual Emergency Room by Stytz et al [12].

A joint team from the University of New Mexico and University of Hawaii developed a single hematoma patient simulator that can run both in immersive and in non-immersive modes [13]. Navigation was implemented using a joystick-based 'grab-and-drag' technique which was adequate for short range locomotion around a single virtual patient. Virtual instruments were also managed by joystick.

A multi-modal *BioSimMER* system for training first responders was presented by Stansfield and colleagues [14]. They successfully employed natural hand and body poses and gestures for navigation and managing virtual instruments. To control the modes of locomotion, the authors used additional input streams, such as mouse and keyboard events. For communication with the virtual patients, a voice recognition system was used with mixed results.

Viciana-Abad et al [15] described a single casualty immersive VR scenario in which subjects were asked to accomplish critical tasks in a stressful situation. In their study, a *CyberGlove* from Virtual Technologies was used for managing the interface. The authors report that even small discrepancies between what people did with the *CyberGlove* and what they saw in VR detracted from the sense of presence.

Several research groups used vision-based tracking of hand gestures for UI purposes. Sato et al [17] applied camera-based gesture recognition for travel and pointing to objects in a virtual city. O'Hagan and colleagues [18] developed a system in which they track and interpret hand gestures for navigation in immersive environments, aiming to free users' hands from any devices that require wiring.

Tollmar et al [19], who also used vision-based motion tracking, reported that immersed subjects preferred real body motions and head motions for travel and orientation over indirect virtual interfaces. In their study, subjects also preferred to trigger actions using hand gestures rather than voice commands. Similar findings were reported by Zanbaka et al [16].

4 Design Principles for VR-Triage Interface

Basing upon results and observations described above, we derived the following guidelines for designing a user interface for virtual triage training system.

User commands must not be missed nor misinterpreted. Trainees are expected to operate in highly stressful environments, thus, demands for UI are very high and 'slips' are not acceptable. That includes blind spots in camera-based tracking systems, where markers can be occluded. Due to the need of protective suits and mittens, vision-based hand and body tracking is not suitable. Magnetic tracking should be used instead. Speech recognition systems may be unrealistic if a trainee is wearing a protective suit. Moreover, virtual victims may not be in a condition to speak, or speak English.

Natural movements should be utilized as much as possible. During triage, trainees must concentrate their efforts on working with victims and not on travel. Thus, we delegate long-distance traveling between virtual victims to some virtual locomotion technique (such as 'point-and-go'), and allow people to move naturally around the victim: walk, turn, kneel and so on. According to findings of Zanbaka et al, travel by walking physically in a large tracked space is better "...where problem solving and interpretation of material is important, or where opportunity to practice is minimal" (paraphrase from [16]).

Use the body in an intuitive and natural way. Whatever people do, they almost always use both hands, thus, we must provide coordination in functionality for both virtual hands, accommodate right and left handedness, make a good use of job division between dominant and non-dominant hands. For more details on that subject, see [20, 21].

Avoid artificial constructs that remind trainees that they are in VR: 3D and 2D menus, excessive use of on screen display, explicit requests for command confirmation.

Finally, we want to minimize usage of additional devices, such as joysticks, mice, game controllers, and keep trainee's hands free. As reported in [15], the mismatch between sensory input and visual response is one of the major factors that break the sense of presence. Using a real joystick for grasping and holding a virtual tool will always be keeping user's eyes and hands in disagreement, unless the virtual tool in question depicts exactly the same joystick.

[1] VR system may even be installed in a climate controlled room with a wide range of temperatures to make the virtual experiences in places like Sahara or Alaska more vivid.

5 VR-TRIAGE: THE SYSTEM OVERVIEW

In this section, we briefly outline the hardware and software components of the system and give some detail on the content of the virtual settings and the training mission.

Hardware A dual processor PC, running at 3.2 GHz with nVidia Quadro FX 1300 graphics card, extended range *Flock of Birds* motion tracking system from *Ascension* with 3 sensors, one for the head and one for each hand, 5DT HMD 800-40 stereo head mounted display, stereo earphones. A trench coat was used to organize all cables from the HMD and the sensors and to support their weight, as shown in Figure 2.

Software Linux OS, *Flatland* information visualization system, developed at the High Performance Computer Center, University of New Mexico [22]. Visual and audio content is rendered with OpenGL and OpenAL APIs. The system runs at fixed rate of 30 frames per second in active stereo mode.

Content The triage scene shows a conference room in a skyrise building, with a minimal set of furniture. Multiple windows display a panorama of city lights. Five victims with various injuries are scattered around the room in different poses. There are several audio and visual distractors, such as a helicopter that periodically appears and makes circles around the building, cell phones ringing, sounds of police cars passing by, etc. Trainees are required to find every victim, provide treatment, if needed, and attach an appropriate tag.

All 3D models were created and animated in *Maya* 3D authoring tool from Autodesk Inc., and then exported into *Flatland* data files using custom plugins. All shapes are optimized for fast rendering by using triangle strips for deformable objects and display lists for rigid objects. Human characters have 6-7 K polygons each (faces alone have about 1K polygons), the number of polygons in the entire scene is close to 170 K. The human characters are rigged using smooth skinning over animated skeletons, each character has approximately 4 animation channels attached, some of which are shared (i.e., blinking and breathing). There are total of 28 motion channels, 6 light sources and 12 sounds in the scene. 3D sound localization and orientation is processed on the same PC.

Behavior In modeling behavior of virtual victims, we adopted a strategy, different from existing triage training applications [10, 11, 14]. Instead of developing detailed and medically correct simulations that control the vital signs, appearance and behavior of the virtual victims, we used a 'static' approach. In our system, a trainee is expected to spend one, at most two minutes with each victim. During that time, he or she must collect all the information needed for treatment and triage. In such a short time frame, we don't expect the victim's condition to change significantly. Neither can we expect from the trainee to detect such changes and derive some meaningful conclusions. Hence, all triage decisions must be based upon a single assessment. That doesn't mean that the virtual victims remain motionless and lifeless. On the contrary, they behave and react to treatment in a manner consistent with the nature of their injuries. Victims can be programmed to be cooperative or not, robust or sensitive to mistakes in treatment. For example, one of the virtual characters has a big bruise on the right side, and she covers it with her hand. When the trainee touches where it hurts, she removes her hand so that the trainee can now use scissors and expose the wound (see Figure 5). This is an example of cooperative behavior. Every victim on the scene has his or her own behavioral function that makes them aware of changes in the environment and controls their responses to these changes. That includes reaction to treatment, too.

6 VR-TRIAGE: POSE-BASED COMMAND LANGUAGE

In this section we give a detailed description of our implementation of the VR triage command language.

6.1 Body Language Components

As explained in section 4, we propose to minimize the use of external input devices, such as buttons, joysticks or mice, and maximize the use of a human body instead. Thus, the building blocks of which we construct all commands are poses.

To compare with the natural human language, different poses play the role of words in a command sentence. As in a human language, certain commands may consist of a single word, like 'stop!'. If the user is traveling, this command is formed by assuming AT REST pose (see Figure 1, top-left). Other commands need additional information, for example, 'start travel *where*'? Such commands are expressed with sequences of poses.

Note that each pictogram in Figure 1 is in fact a generalization of a family of poses that carry the same semantic meaning. For instance, a POINTER can be realized by pointing with any hand in any direction from any position: standing, sitting, squatting, etc. The key feature here is that one hand is extended at full arm length. Key features may be grouped and new poses defined. Note, that the poses themselves rest on a human side of the human-computer interface, they are nothing more than convenient mnemonics to help users remember the 'vocabulary' of the command language. The command interpreter in our system works with key features instead, which are detected and processed in real-time continuously.

Technically, the features are implemented as flags, set to true or false after converting each raw sample read from the *Flock of Birds* into data items of various types, such as hand-head and hand-hand proximity, mutual orientation, absolute and relative velocities, etc. Presently, the command interpreter recognizes 16 distinct features for each hand, such as *hand-is-extended, hand-is-up, hand-head-contact, hand-palm-up, hand-fast-drop* and the like.

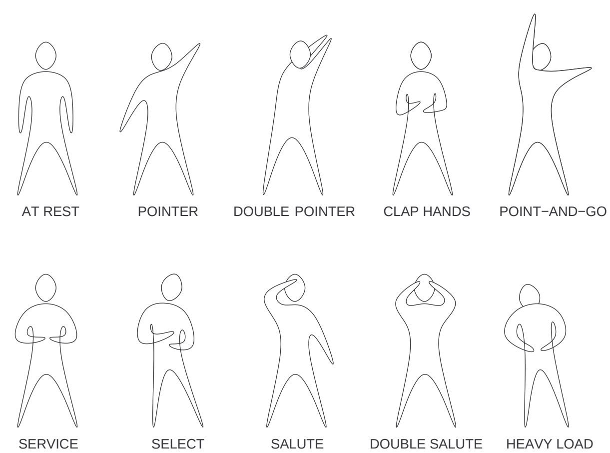


Figure 1: The vocabulary of the VR triage command language. The top row shows poses used in travel commands. The poses in the bottom row are related to handling tools.

6.2 Intention + Confirmation = Command

Most commands are implemented as 'intention+confirmation' sequences. For example, to start travel, a user must specify either direction or destination of intended travel and then issue a confirmation, a 'go!' signal. Similarly, when grabbing a tool, user first shows his or her intention by selecting a tool and then confirms or cancels it.

There are two advantages in breaking commands into explicit intention and confirmation components. Firstly, the need of a clearly expressed confirmation makes it less likely that the command will be executed unintentionally, by chance. Secondly, by varying the representation of each component separately, we can find the most convenient and intuitive implementation for the entire command.

Commands are usually context-dependent and can be grouped into travel, tool access, and tool application. This classification is suggested by the nature of triage itself, where the learner is required to approach a victim, select an instrument from a toolbox, apply the instrument, and repeat the process with the next casualty. Context-based interpretation helps to disambiguate commonly used poses, for example, pointing. When the user is not moving, an extended hand is interpreted as an intention to start travel; in travel mode, an extended hand means 'change direction' or 'increase speed'. When the user is selecting or using a tool, an extended hand has no special meaning. Presently, the system recognizes the following modes, or contexts: idle, calibration, travel, tool access, tool application, pause, and telescopic view.

6.3 Calibration

To be able to read user's poses correctly, the command interpreter must have certain biometric data on that user, such as arm length, body height, neck length. For that purpose, all new users go through a short calibration routine, during which they are asked to extend and hold their dominant hand in three directions: up, down and forward. The head-to-hand distances are captured; the arm length and vertical distance from the shoulder joint to camera are derived. Also, the system captures the level of the natural hand tremor, specific for each user. This value will be used in determining pointing directions, needed for travel.

Calibration takes approximately 30 seconds and can be initiated by the user inside VR or by an operator from the console (see Figure 2, left). The calibration process effectively turns the three general purpose tracking sensors into a virtual camera and virtual hands, synchronized with the user's body. During calibration, one of the virtual hands is assigned as a dominant hand.

Figure 2: VR session starts with calibration (left). Going forward (top). Picking a tool (bottom).

6.4 Virtual Hands

Virtual hands are used in all commands. Visually, they are implemented as animated objects with deformable skin and internal skeletal structure. Each hand maintains its internal state, which can be POINT, OPEN and CLOSED. For each state, there is a distinct hand shape that gives users additional clues about what they can do with the hand at this moment. Transitions between states happen in finite times and are visualized with short animations, as shown in Figure 3. During transitions, the hand is in undefined state and can't be used for anything. This implementation provides natural damping of unwanted oscillations between states, which may happen when the hand repeatedly picks and drops a virtual object. Also, this delay serves as 'cool-off' time when changing contexts, for example, from tool application to traveling.

Dominant OPEN hand can be used to work with objects. Both dominant and non-dominant hands can be used to form commands that are not related to travel. When a dominant OPEN hand picks an object, it changes the state to CLOSED. In this state, the hand can only manipulate or release release the object. After releasing the object, the hand becomes OPEN again. Both dominant and non-dominant hands can toggle between OPEN and POINT states. In POINT state, the hand can only be used for travel.

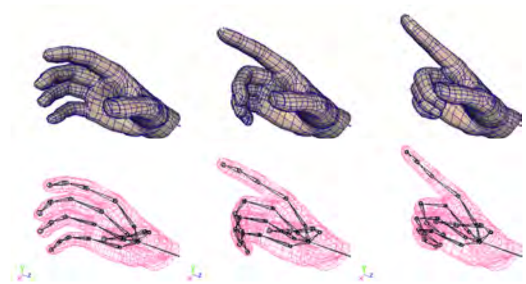


Figure 3: Virtual hand, the skin (top) and the skeleton (bottom). In OPEN state (left), the dominant hand can pick objects. In POINT state (right), the hand serves as a pointer for specifying travel directions or destinations. In the transitional state (middle) the hand can't be used for anything.

6.5 Travel Commands

The extended range *Flock of Birds* system tracks positions and orientation of the sensors within 8 foot radius, providing sufficient space for working with a single patient, moving naturally: walking, turning, kneeling. Inter-patient travel is implemented using 'point-and-go' virtual locomotion technique: the user selects a destination or direction of travel and the navigation system 'teleports' him or her there automatically. To avoid breaks in continuity of perception, relocations happen with a finite speed, varying between walking and running (5 km/h to 20 km/h).

6.5.1 How to Point

To start travel, the use must point in the direction of travel or point at the destination object. In both cases, a correct pointing pose must be used. A pointing arm must be extended for more than 75% of its length. The hand must be placed at the chest level or higher when standing or at the chin level or higher when squatting. In general case, the hand must be held above 80% of the current head elevation above the floor. This rule filters out false travel intentions when the hands are at rest position, hanging down at full arm length.

When the user's real hand becomes a pointer, so does its virtual twin: the index finger extends forward, as shown in Figure 3, right. Interestingly, most people that tried our system, involuntarily extended their index fingers also, mimicking the shape of their virtual hands (Figure 2, top right).

6.5.2 Direction-Based Travel

In this mode of navigation, the user moves in the direction from the camera towards the tip of the index finger on the pointing hand. The pointing hand is not required to be in the viewing frustrum, which allows moving forward, backward and sideways without turning away from the current object of interest. We believe that this way of specifying the travel direction is more suitable triage training than using the view direction or torso orientation, as in [14]. By decoupling the direction of travel from direction of view, we avoid overloading natural body movements with extra functions, which can make the whole exercise less naturalistic and more tiring.

The intention to start travel is detected when either hand assumes a pointing position: arm extends 75% or more, aiming high. The travel is confirmed when the hand is found to be pointing in the same direction for a specified time interval. The 'same direction' condition is checked with the user-specific shake tolerance, which is captured during calibration.

We found that the confirmation timeout of 750 msec allows to travel comfortably along curved paths by following the slowly moving hand. Fast hand movements are ignored. If the hand keeps pointing in the same direction and is in view, the travel speed is increased. For convenience, we will refer to this type of travel using terms *direction-based*, *hand-based* and *free-style travel* interchangeably.

6.5.3 Target-Based Travel

In target-based travel, an intention to start travel is indicated by pointing at a *target object*. When a hand assumes the pointing position, a ray is cast from the camera through the tip of the index finger. The ray is checked for intersections with all objects that have registered themselves as targets. For instance, all virtual victims are such targets. All targets hit by the ray are sorted along the ray distance and the closest target is chosen as a travel destination. Unlike free-style travel, which allows blind pointing, target-based travel requires that the hand and the target are both in view.

Structurally, a target is a simple wrap around a standard scene object (a node in a scene graph hierarchy), with additional information relevant to navigation and selection: bounding volumes of various types, best viewing distance, etc. Also, target keeps track of how long it's been in selected state.

Figure 4: State transitions of travel targets.

Functionally, targets are implemented as state machines shown in Figure 4. An IDLE target becomes SELECTED when the user points at it with either hand. The travel intention is detected. When the travel is confirmed and initiated, the target changes state into BEING APPROACHED. When the target is reached, it becomes TAKEN. The target returns to IDLE state when the user: (a) cancels the pending travel command (from SELECTED), (b) stops traveling (from BEING APPROACHED), (c) moves away from the target (from TAKEN).

We have experimented with various types of confirmation for this type of travel. Four methods gave good results. Confirmation may be given, (a) by pointing at the target with both hands (Figure 1, pose DOUBLE POINTER), (b) by raising the other hand up (Figure 1, pose POINT AND GO), (d) by looking at the center of the selected target, (c) using a time-out. All these methods triggered the travel command reliably.

Once travel to a target has started, the navigation system tracks the current location of the target and dynamically corrects directions and speed of travel. That allows to close on a moving target automatically, without pointing at it all the time. The final destination point is computed so that the user ends up standing at a comfortable distance in front of the target object. For human characters, we used the value of $1.5R$, where R is the radius of the bounding sphere of the character.

6.5.4 The Rules

Besides starting travel, the user must be able to modify or cancel it effectively. After exhaustive trial and error experimentations, the following rules for processing travel commands crystallized.

- If the user is already moving free-style, reset all selected targets, interpret hand positions as commands for directional travel (targets are not processed). That rule allows to change direction of travel on the go, without making a stop.
- If the user is not moving yet, and one of the targets is selected, use hand positions for target-based travel only. That allows to complete the travel command by giving a confirmation signal.
- If the user is already moving towards a target and keeps pointing at the same target, continue travel to the target. The target may be moving. Continuous pointing at the same target is redundant.
- If the user is already moving free-style and keeps pointing in the same direction, and the hand is in view, increase speed. However, continuous 'blind' pointing will result in traveling at constant speed only. The reason behind this rule is that in normal human movement, most acceleration typically occurs only in forward directions, but not in lateral or backward directions. Also, this rule can be considered a safety precaution.
- To stop a free-style travel, drop the pointing hand.
- To stop a target-based travel, point away from the target and drop the hand.

Continuing the parallel with the natural language, The Rules serve as the grammar for our travel language, allowing the system to disambiguate and link sequences of poses into valid and meaningful command sentences. These commands provide interface for all travel needs.

6.6 Virtual Tools

Virtual tools are means for examining and delivering care to virtual victims.

6.6.1 Tool access and storage

All tools are placed on an invisible tool tray, permanently attached to the non-dominant hand. When a user wants to access the tools, he or she needs to make a gesture as if they are holding a real tray: palms up, hands in view, as shown in Figure 1, pose SERVICE. The tray turns visible and the tools become accessible. To select a tool, the user touches it with the dominant hand, while keeping the tray open. Confirmation is given automatically on a time-out and the tool jumps into the hand. To return the tool, the user must put it in contact with the tray and the tool will jump back to its place.

To make this interface more user-friendly, we applied a hysteresis for the direction of tool jumps. If the tray is open with the intention to grab a tool (the grabbing hand being empty at that moment), grabbing is easier than releasing: the confirmation time out is shorter. If the user opens the tray while holding a tool, the situation is reverse: the tool will 'gravitate' towards the tray.

Figure 5: Virtual tools. The tray is open (top), scissors have been applied to cut the clothes (left), the victim gets a green tag (right).

6.6.2 Tool application

An intention to apply a tool is issued by placing it close to the area of application. Confirmation is issued on a time-out. Some tools, such as triage tags, attach themselves to the point of contact, which is the forehead of the victim (see Figure 5, bottom-right). The roll of bandage wraps around a wound. Scissors perform a cutting animation after a contact with clothes is made.

The tools themselves are not very intelligent and they should not be. The whole body of knowledge about the consequences of each tool's application is stored in behavioral functions of virtual victims. That allows us to reuse the same tools with different patients, and not the other way around.

6.7 Other Commands

Head Lamp By touching own forehead with one hand (Figure 1, pose SALUTE) the user toggles a spot light that is attached to camera. Initially the light is turned on.

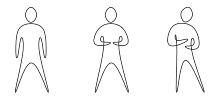
Binoculars By covering both eyes (Figure 1, pose DOUBLE SALUTE) the user turns on virtual binoculars: the view is magnified 4 times. Retracting either hand turns binoculars off. While the binoculars are on, the user can't neither travel nor work with tools.

Backpack This command will be used for storing and accessing additional tools. If the tray holds the most frequently used instruments and supplies, the backpack will contain the rest. It will be accessed by reaching out with both hands behind the back (Figure 1, pose HEAVY LOAD).

Go To Start Position By clapping hands three times, users can jump to the position where the mission has started. This command was implemented mostly for debug purposes.

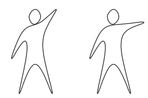
6.8 Pictorial Summary of Commands

In the following diagrams, commands starting with  (AT REST) pose, are only available when the user is not traveling.

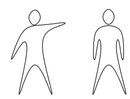


aceess the tray to pick or return a tool

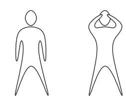
travel towards a target



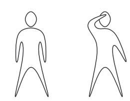
travel free style



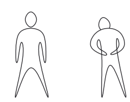
full stop



toggle binoculars on/off



toggle head lamp on/off



access the backpack (pending)

jump to start position (clap hands)

7 Experiments

In September 2006, the *VR-Triage* system was tested at the John A. Burns School of Medicine, University of Hawaii. Over 40 volunteers, the majority of them medical students, were asked to perform a simplified triage scenario. Their mission was to explore the scene, find all victims and tag them. In order to accomplish this mission, volunteers had to learn how to navigate around the scene and how to access and use the tools, in this case, triage tags.

Before going on the 'real mission', each subject was calibrated and placed into a training zone, a highly abstract and rather void virtual world, to practice navigation and tool manipulation commands. To complete the training, subjects had to approach and tag two human-like characters, and, after doing so, leave the training zone by directing themselves out through a wooden gate. After passing the gate, the subjects 'entered' the scene of triage, and the mission started. None of them had previous experience with VR.

In the beginning of the exercise, immediately after calibration, most people looked frozen, standing very still and staring straight ahead. Very soon, they began to relax and started to turn, walk, and finally, use their hands, all of that happening within one minute. We suggest that this is an indication that tracking mediated the real body movements into VR adequately, and the whole system was reasonably comfortable.

Overall, *VR-Triage* was received with great enthusiasm. On average, subjects were able to complete training in 2 minutes, and the mission itself in 5 minutes. Best time for completing the triage mission was 1:57 min, worst time 10:38 min, median 3:40. Out of 43 subjects, only two didn't complete the exercise: one felt uncomfortable with the HMD (it was too loose), the other didn't offer any reasons.

For each subject, we collected data logs for measuring *completeness* of their actions. We define completeness of a command as the ratio between the number of executions to the number of intentions. A 100% completeness is achieved when every intention results in command executions. Cancellations reduce completeness. This characteristic is aggregate and depends, among other things, on the quality of the human-computer interface and also on individual qualities of each subject. People who tend to change their mind frequently, are unlikely to achieve high scores.

The mean values of completeness for travel and tool application are 90.0 and 87.7, respectively. The results are based on a 41-subject sample for travel and a 26-subject sample for tool related tasks.

For travel commands, we measured completeness separately during training and during the mission. The large number of subjects (41) allowed us to treat the human factor as a random variable and regard completeness as a characteristic, predominantly related to the usability of the interface.

The distributions of completeness during training and during the triage mission are shown in Figure 6. At a glance, we can say that in both environments people traveled very confidently: all subjects scored above 70% and the modal values for both cases are 100%. The question whether the prior training was helpful or not remains open for discussion. Statistically, the means of the two distributions are indistinguishable. Thus, the only indisputable conclusion that we can draw is that training did not appear to impair performance. However, a higher complexity of the mission environment gives us reasons to believe that training actually did help. The differences between the two worlds are significant, especially where navigation is concerned. In the training zone, both characters are standing in clear view and can be approached easily. During triage mission, all victims are scattered around the scene in various poses, lying on the floor and leaning against the walls. Navigation in close proximity of the walls and windows is not as easy as elsewhere. To prevent subjects from falling out of windows and going through the walls, traveling is allowed only inside the room. To enforce that, the perimeter of the room is surrounded with a 'cushion zone', where speed of travel is gradually reduced to zero as the subject move deeper into the zone. Traveling in the training zone is completely unrestricted.

With all that in mind, we offer that identical mean values of completeness in both areas indicate that training actually helped subjects to improve their navigational skills.

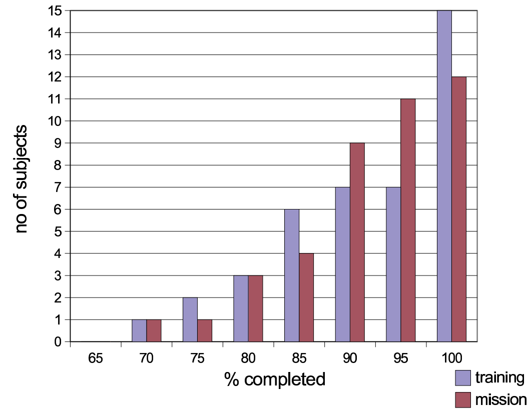


Figure 6: Distributions of completeness for travel commands during training and the during triage mission. Mean values 90.22 and 90.46, standard deviations 9.42 and 7.89 respectively.

8 Conclusions and Future Plans

We have presented a working prototype of the immersed VR system for training triage skills, with the emphasis on designing an efficient and reliable command language. The system was successfully tested with a large number of subjects; valuable input was collected for further improvements. It was demonstrated that for navigation and tool application tasks most subject were able to use the interface at high levels of efficiency.

During development, we have identified a number of interesting companion problems that merit additional studies. For example, similarities between the natural language and the pose-based language were noted but not yet explored. It seems likely that techniques and methods from the field of natural language processing may offer new insights for further development of the command language. Another interesting problem is how to incorporate a sense of tiredness in the navigation system, to promote economy of motion and virtual travel.

In the near future, we plan to run more tests in order to evaluate and improve the usability of the command language. Long term plans include testing the efficacy of *VR-Triage* for teaching and training cognitive skills needed in triage. For that purpose, a scoring system and a set of monitoring tools must be developed for tracking behavior and performance of trainees.

We believe that *VR-Triage* achieved a level of sophistication which allows development, implementation and evaluation of real-life training scenarios, custom-made for specific audiences, both civil and military.

Acknowledgements

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Appendix H
Using a Heuristic Evaluation Model for the Development of Virtual Reality Triage

Using a Heuristic Evaluation Model for the Development of Virtual Reality Triage

Introduction

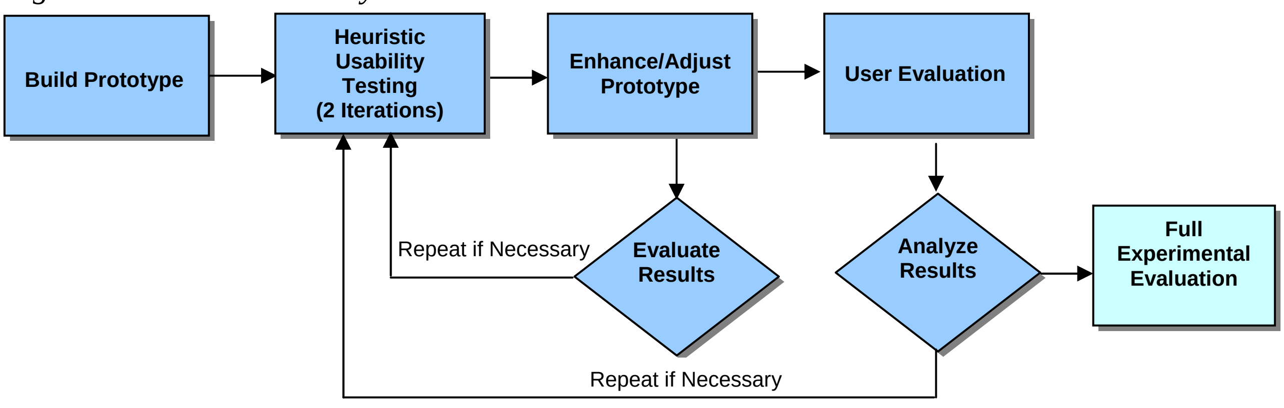
The Telehealth Research Institute is currently developing VR Triage, a software application to train mass casualty triage in a virtual reality environment. The purpose of VR Triage is to provide a readily available cognitive training platform that can supplement a didactic triage curriculum. At a disaster site, triage may be the most important medical task performed (Waeckerle, 1991), therefore it is vital that first responders and medical personnel are thoroughly trained and prepared for action. However, there are few opportunities to obtain the training and experience necessary for optimal performance in mass casualty emergency situations. A VR simulation application can provide this training more readily and at a lower cost than expensive large scale mass casualty moulage training sessions, which are currently being used for this type of training. As key to the success of VR Triage, it is vitally important that the application is usable and able to satisfy the needs of the training, without hindrance of the technology itself. Therefore, in the development process of VR Triage, we have developed and utilized a heuristic usability evaluation model.

The evaluation model that we have developed consists of two iterations of expert heuristic testing and one evaluation using typical users of the system. In examining the literature, studies have evaluated virtual reality environments using expert heuristic evaluations, but have implemented evaluations that use only one iteration of expert user testing (Sutcliffe & Gault, 2004c; Gabbard & Hix, 1999a). A study conducted by Tang et al., evaluating a (non-VR) telemedicine system, implemented two iterations of the expert heuristic evaluations and found that utilizing two iterations resulted in improvements to the interface. Approximately half the number of usability violations were found in the second iteration (Zhihua Tang et al., 2006). The evaluation model that we have designed combines two iterations of expert usability testing with one evaluation conducted by users, resulting in a three-step model (see Figure 1).

Combining the expert heuristic evaluations and user evaluation has two main benefits. First, the expert evaluators will detect and address the major problems in the interface without having to “waste” users, since they are often more difficult to recruit as evaluators. Secondly, the user evaluation will tend to find different types of issues (violations of cognitive principles versus functional impact on users), which supplements the expert heuristic testing rather than overlapping it (Jakob Nielsen, 1993).

In sum, the evaluation model that we have implemented is novel to evaluating virtual reality environments and provides an analytical method for the evaluation of the software in the development phase, producing a guideline of problems that can be used for redesign and modification to improve the usability of the application.

Figure 1. Heuristic Usablity Evalaution Model



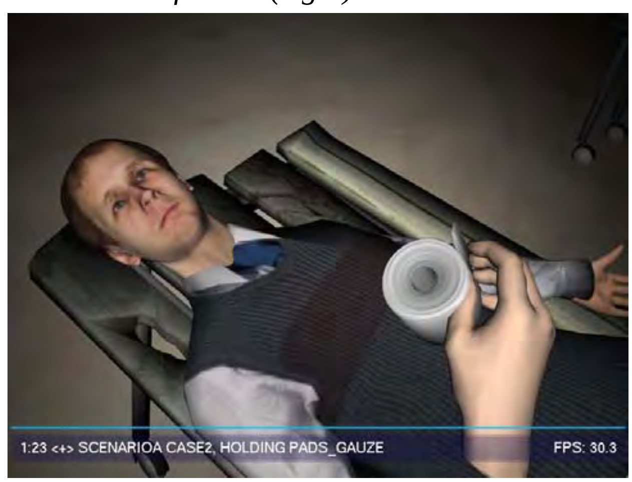
Methods

The expert heuristic usability evaluation and the user evaluation both consisted of five person participants. Neilson et al. (Nielsen & Landauer, 1993c) found that for software usability testing, the more users you have testing the software, the less new information will be learned. In other words, the first user will contribute about 30% of the usability issues and problems. The second tester will contribute less new information since there will be some overlap with the first tester. By the fifth usability tester, 85% of the usability problems will have been identified; efficiency is lost using additional testers since most of the information will be replicated.

For the expert heuristic evaluation, the same five expert evaluators were used for both iterations. The experts included one computer science professors, whose research focus is human-computer interaction, one human factors professor and three doctoral students specializing in human-computer interaction. All expert evaluators were recruited from the University of Hawaii at Manoa. The user evaluation consisted of five medical students from the University of Hawaii. The purpose of the expert heuristic evaluators was to test the software and assess whether the interface violates known cognitive principles based on the heuristics provided. On the other hand, the user evaluators assessed the software based on whether the system reaches the user's expectations and needs for completing the directed tasks.

The heuristics used for this study are based on Sutcliff and Gault's (Sutcliffe & Gault, 2004b) and Neilsen's evaluation criteria, (Jakob Nielsen, 1993) customized to specifically address virtual environments (see Table 1 for list of heuristics used). Both the expert and the user evaluators were given representative tasks used in VR Triage. A headmount display was used to view the scene in tree dimensions (3D), and motion trackers were used for tracking head movement and on hands, which controls the use of tools and navigation in the VR scene using hand gestures (see Figure 2).

Figure 2. VR Triage hardware setup (left) and screenshot of scene (right)



Both sets of evaluators were assigned the task to apply triage tags to five patients in a scene. A practice session orienting and training the users on how to navigate to each patient and utilize tools in the environment was conducted prior to the actual assigned task.

Table 1. Evaluation Heuristics

Heuristic	***Description***
Natural engagement	The interaction in the virtual triage environment should approach the expectation of the user a much as possible. Ideally, the user should not be aware that the virtual environment is not reality.
Compatibility	The objects in the virtual triage environment (medical tools, office space, furniture, etc…) should correspond as close as possible to the expectation in the real world. This includes their behavior, affordance and task action.
Natural expression	The representation of self should allow the user to act and explore in a natural and expected manner and not restrict physical actions. The absence of haptic feedback may hinder this area.
Close coordination of action and representation	The representation of self, behaviors and actions should map to the user's actions. The response time between the user's movements in the real world to that in the virtual world should take less then 200 ms to avoid potential motion sickness.
Realistic feedback	The effect of the user's actions on virtual objects should be immediately and conform to the user's perceptions, expectations and laws of physics.
Faithful viewpoints	The visual representation of the triage virtual environment should map to the user's normal perception. Head movement and viewpoint changes should be rendered without delay.
Navigation and orientation support	The user should always be able to orient themselves in the virtual environment and be able to return to known, present positions.
Clear entry and exit points	How to enter and exit the virtual environment should be clearly communicated.
Consistent departures	Design compromises or substitutions in the virtual environment should be consistent and clearly marked or communicated.
Support for learning	Active objects should have cues and, if necessary, have some sort of explanation of their purpose in the virtual environment.
Clear turn-taking	When the system initiates control of the environment, it should be clearly signaled and conventions should be established.
Sense of Presence	The user's sense of present "being there" in the virtual world should be as natural as possible.

After completion of the task portion of the evaluation, the expert evaluators conducted a written evaluation of the system using the heuristic criteria as the base guideline. The expert evaluators also ranked each of the heuristic criterion on a seven-point Likert scale using the Heuristic Evaluation Survey, where one is *severe* and seven is a violation that is minor or *cosmetic*. After the second iteration of the heuristic evaluation was completed, the five user evaluators performed the same representative tasks to test the usability from the user's standpoint. The users also ranked each of the heuristic criterion on a seven-point Likert scale using the Heuristic Evaluation Survey. Both the experts and users also completed Target Usability Survey. This survey assesses usability issues in the software, which include issues of learnability, efficiency, memorability, errors and satisfaction. A seven-point Likert scale was used for the assessment, where one is *unacceptable* and seven *exceeds* expectations (See Table 2 for description of issues).

Table 2. Target Usability Survey

Issue	***Description***
Learnability	The system should be easy to learn, so that the user can rapidly start performing tasks in the environment.
Efficiency	The system should be efficient to use, once the user has learned how to use the virtual triage, objectives should be able to be accomplished similar to that of the real world.
Memorability	The system should be easy to remember, so that a user may return to the virtual triage environment without having to learn again how to use the interface.
Errors	The system should have a low rate of interface errors (i.e. errors trying to navigate, errors trying to apply tools, etc…), and if errors occur, users should be able to easily recover from them. Catastrophic error must not occur.
Satisfaction	The system should be pleasant to use, users must be satisfied and like using the system.

Statistical Analysis

Data was analyzed using SPSS 14.0 software package (SPSS, Chicago, Illinois, USA). The data consists of results from the Heuristic Evaluation Survey and Target Usability Survey. The primary outcome measures were the difference between the two expert evaluations and the user evaluation. This is not an experimental study where sample size determination is not applicable. The usability evaluation (heuristic and user) is a development model to ensure that a system is designed and developed with usability in mind. The ratings and problem list will be the basis for prioritizing the modifications of the software. Scores should increase to minimum acceptable levels and these should mirror subjective comments.

Descriptive statistics will be utilized to examine results. The mean net results of the severity ratings from the heuristic criteria and target usability survey are assessed. A chi-square analysis was used to detect differences between the two expert heuristic evaluations and the user evaluation.

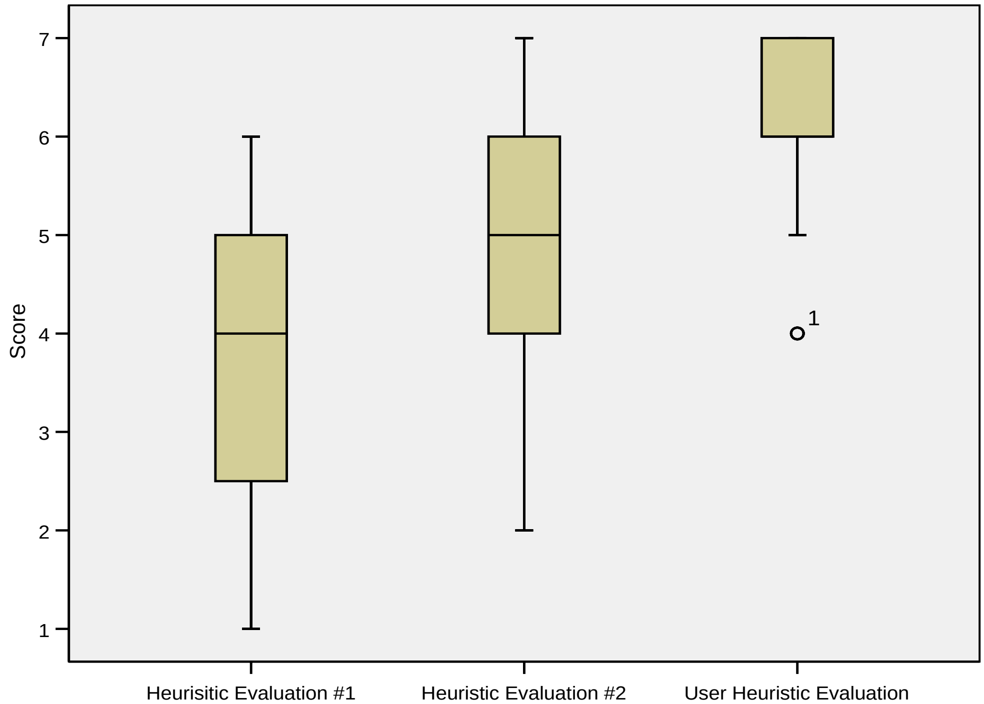
Results

In analyzing the results of the Heuristic Evaluation Surveys and the Target Usability Surveys, Pearson's Chi-square analysis was utilized in analyzing the differences between the three evaluation groups, expert heuristic evaluation #1, expert heuristic evaluation #2 and user evaluation. The results showed a statistical significant difference ($P < .05$) in scores between the three groups. The means, standard deviations, and results of the statistical analyses are displayed in Table 3. Figure 1 shows there was an improvement trend in scores across the three groups.

Table 3. Expert and user Heuristic Evaluation Surveys, means and standard deviations

	M	*SD*
Expert Heuristic Evaluation #1	*3.69*	*1.44*
Expert Heuristic Evaluation #2	*4.83*	*1.40*
User Heuristic Evaluation	*6.26*	*.94*

Figure 1. Comparison between expert and user Heuristic Evaluation scores

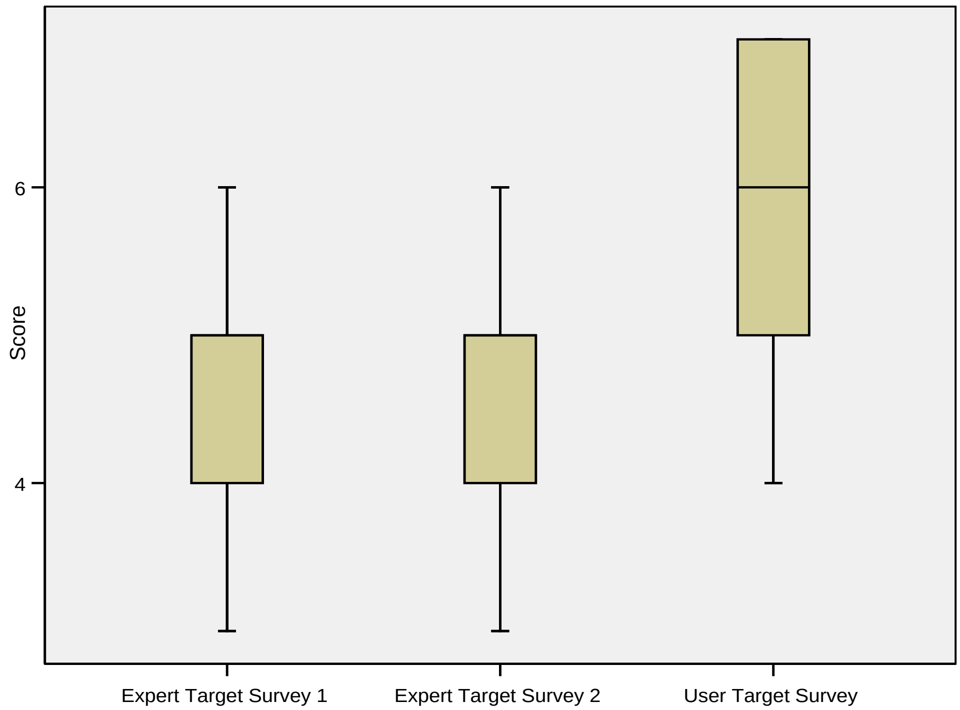


For the Target Usability Surveys, the means, standard deviations are displayed in Table 4. The results using Pearson's Chi-square analysis showed a statistical significant difference (P < .05) in scores between the three groups. Similar to the Heuristic Evaluation Surveys, Figure 2 shows that there is a general trend in improved ratings across the three evaluation groups.

Table 4. Expert and user Target Usability Survey, means and standard deviations

	M	*SD*
Expert Heuristic Evaluation #1	*4.52*	*.82*
Expert Heuristic Evaluation #2	*4.64*	*.91*
User Heuristic Evaluation	*6.00*	*.866*

Figure 2. Comparison between expert and user Target Usability Evaluations



Discussion

The results showed an improvement trend across the three evaluation groups. The user evaluation demonstrated the least amount of usability problems (see Figures 4 and 5 for comparison results if each survey item). This may have to do with the fact that the users are not experienced in identifying usability issues, as with the expert evaluators, but are focused more on accomplishing the tasks assigned. The overall trend in the reduction of usability issues found in the expert evaluations and the user evaluation demonstrates that the iterative process of usability testing did improve the user interface of the VR Triage software. After software improvements resulting from the expert evaluations, as observed by the testing coordinator, the users had few issues in actually running the software and completing the assigned tasks. In addition, the highest ranked heuristic criterion for the users was the *Sense of Presence*, all users ranked this at the highest point on the Likert scale, which means a minimal violation of the Heuristic. This is significant since it is a goal in the field of virtual reality to be able to substitute the virtual environment for real world experiences. Especially in training, it is important for behaviors in the virtual world to be consistent and map with similar circumstances of that in the real world. A key element in achieving this is the participant's sense of presence. Presence in virtual reality is the feeling of being more engaged in the virtual enviornment than surrounding physical world; in other words, a sense of being "there" in the virtual world, versus in the real world (Bystrom et al., 1999; Witmer & Singer, 1998).

Figure 4. Heuristic Evaluation Survey results by question

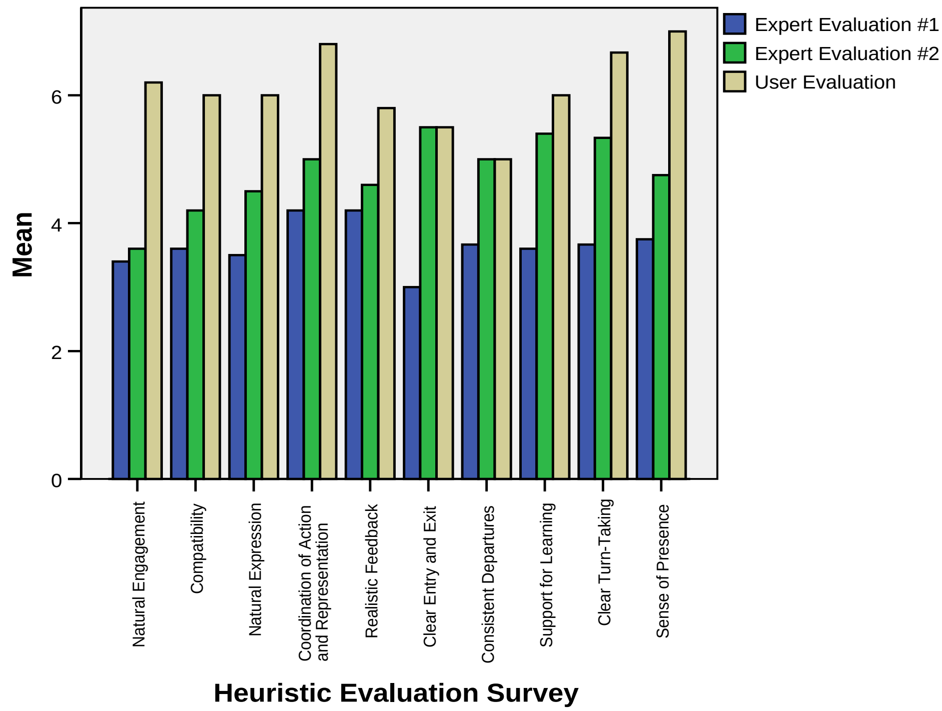
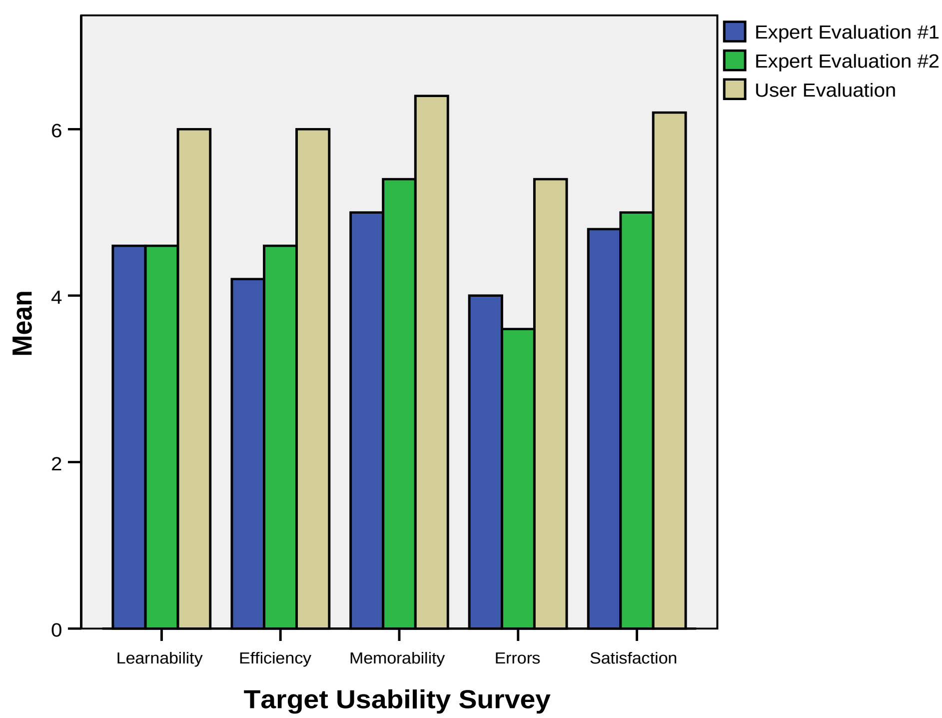


Figure 5. Target Usability Survey results by question



In looking at the individual questions for the Target Usability Survey, Figure 5, the usability area that rated the highest mean in all three evaluation groups was in the area of *Memorability—The system should be easy to remember, so that a user may return to the virtual triage environment without having to learn again how to use the interface.* Second highest for all three groups was *Satisfaction—The system should be pleasant to use, users must be satisfied and like using the system.* This can lead us to conclude that the VR Triage software was easy to use and ranks high in the user's ability to use and reuse the system.

Table 5 shows some of the usability issues identified by the expert evaluations, and the resulting improvements to the VR Triage software.

Table 5. Usability issues and improvements

Usability Issues	***Improvements***
Hard to move around patients in scene	Moving restrictions in the vicinity of victims were simplified; the users are allowed to walk at normal pace
Teleportation too fast	Teleportation speed was adjusted for generic users and is now adjustable during calibration time
Hard to navigate close to walls	A cushion zone, which acts as speed damper near all windows and walls has been reduced: cushioning starts much closer to the perimeter of the room now
Hard to see/reach some objects on the tray	Tool pick/drop interface was completely redesigned from touch-and-pick to point-and-pick metaphor. Now the tray is placed in front of the subject and selection is performed by pointing with an index finger, which is much more precise than grabbing; special care was taken to eliminate double-picking when more than one tool jump to user's hand. In general, this interface is less dependent on users' biometrics, such as arm length and neck length. All tools are always in view when the tray is open
Lack of sounds/feedback when touching/using objects	All tools provide audio feedback on touch, pick, apply and drop events with distinct sound effects
Tools should have better, consistent visual/audio feedback	Visual feedback was also added, which is uniform and consistent for all tools
Users must be able to make mistakes with feedback from the system	Users now can use all the tools with all the patients, for example, blood pressure cuff will always give blood pressure readings when used properly; when tools are used recklessly, warning sound is given: for example, when subjects touch patients faces with scissors. This improvement allows subjects act on their own, without prompts from VR operator which tool to use with each patient.
No clear entry and exit points	The triage mission has now clearly marked entry and exit events: a voice narration recorded by Kris Hara, announces that "The mission has been started" and "The mission is now ended, follow the instructions from your facilitator".

Conclusion

Heuristic evaluations have been identified and utilized as a valid method to test usability for virtual reality and virtual environments, (Sutcliffe & Gault, 2004a; Bowman et al., 2002; Gabbard & Hix, 1999b; Nielsen & Landauer, 1993b) as well as medical applications.(Tang et al., 2006) As described by Nielsen,(Nielsen & Landauer, 1993a) an heuristic evaluation is a method whereby the user interface of a software application is assessed for usability aspects using guidelines or heuristics. Heuristic evaluations are best used in the early stages of design to help guide the design and address usability problems.

Because of the limitations of currently available VR technology, there have been few applications that address the issues of triage. However there have been a few applications developed, which include the following. The Virtual Medical Trainer (Kizakevich et al., 1998) is geared towards the Army medical community with the objects of accurate physiologic patient simulation based on the guidelines of the Basic Trauma Life support and Advanced Trauma Life Support curricula. MediSim (Chi et al., 1997) is another VR application that uses a simulated victim for medical assessment and stabilizations. This is a battlefield simulation where the user interacts via commands from menus. BioSimMER (Freeman et al., 2001; 99 A.D.) is an immersive emergency simulation relating to a biological attack. Trainees must triage, diagnose and treat the victims. BioSimMER uses a head mounted display and motion gestures for navigation. The JUST VR (Andreas Manganas et al., 2004; M.Ponder et al., 2002) is designed to simulate training under stressful conditions. A rear projection system is used whereby a virtual assistant (real person that is also mapped to the virtual world) helps the user with navigation and tasks using natural language.

Virtual reality (VR) environments offer advantages of being able to uniquely simulate the stress and realism of the disaster situations (Kobayashi et al., 2003; Vardi et al., 2002). VR provides a platform where trainees can have repeated dynamic interaction with patients with a wide variety of possibilities in a simulated realistic environment. One of the primary goals for VR is to substitute the virtual environment (VE) for real world experiences. Behaviors in the virtual world have the ability to map to similar events in the real world (North et al., 2005). The sense of presence or the feeling of actually “being there” can help lower the psychological barriers in real emergency situations (such as sight of blood, or distracting sounds such as sirens or people yelling)(Rizzo et al., 2005).The sense of presence is also enhanced by viewing the graphics in stereo (3D) using a head mounted display or 3D projection system. Motion trackers can be used so the user’s movements are consistent with the virtual environment.

Nonetheless, no matter how intricate or sophisticated the software is, if the users have difficulty using the software, the success of implementation of the application may be greatly hindered. Incorporating an iterative process in the software development is important since the software designers will not get solutions correct the first time around (Gould and Lewis, 1985). A poor user interface can place high cognitive demands and in turn divert attention away from the primary learning tasks or goals. Whereas an effective (usable) interface matches the cognitive expectations of the user, and the user is able to focus on the task to be completed, rather than the process in which the task must be done (Metros & Hedberg, 2002). In other words, the usability of an application is vital for achieving the learning objectives intended. The heuristic usability evaluation model that we have developed is a systematic, efficient and low cost usability inspection method that is designed to identify usability problems early in development life cycle so that they can be addressed in the iterative development process.

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Appendix I
Virtual Reality Environments for Medical Training and Therapy: Surgical Skills Acquisition, Virtual Beach, Virtual Patient and Virtual Nephron

Virtual Reality Environments for Medical Training and Therapy: Surgical Skills Acquisition, Virtual Beach, Virtual Patient and Virtual Nephron

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Background

Virtual reality (VR) environments act as an addendum to established educational, training or therapeutic methodologies. VR can be applied to a variety of medical settings where standard educational techniques are not applicable or feasible. VR enhances visualization and interaction. Users are immerged into an augmented reality with life-like characteristics. Virtual reality does not replace but raises training and educational standards by offering supplementary learning material in addition to basic imagery and text.

Method

A set of virtual reality simulations has been created for the purpose of education, training and therapy by the Telehealth Research Institute. The simulations use motion tracking, joystick and Haptics devices for user input; 3D stereo rendering is utilized for visual output.

Results

A surgical skills trainer was implemented to train medical students and professions in laparoscopic surgery (Figure 1) [3]. A virtual beach was built for therapy of pain management, stress reduction and potentially for Posttraumatic Stress Disorder (Figure 2) [4]. A Hematoma simulation, based on a problem case at the University of Hawaii medical school, teaches the process and treatment of a subdural hematoma victim (Figure 3) [1]. The processes of the countercurrent mechanism of the nephron, which are known difficult concepts to learn, are graphically depicted and interactive for an alternative mode of learning (Figure 4) [2].

Figure 1 - Virtual Reality Surgical Simulator

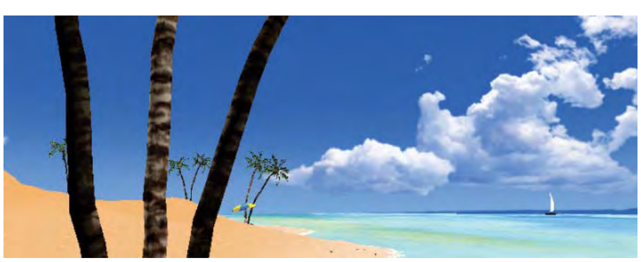

Figure 2 - Virtual Beach

Figure 3 - Virtual Patient

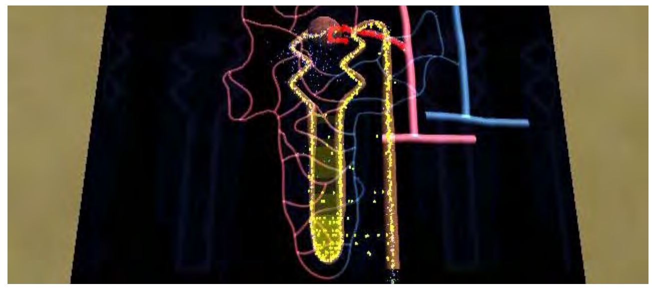

Figure 4 – Virtual Nephron

Conclusion

Virtual reality can be applied to medicine in numerous ways; from basic educational visualization [2] to therapy [4], to training [1] and skills acquisition [3].

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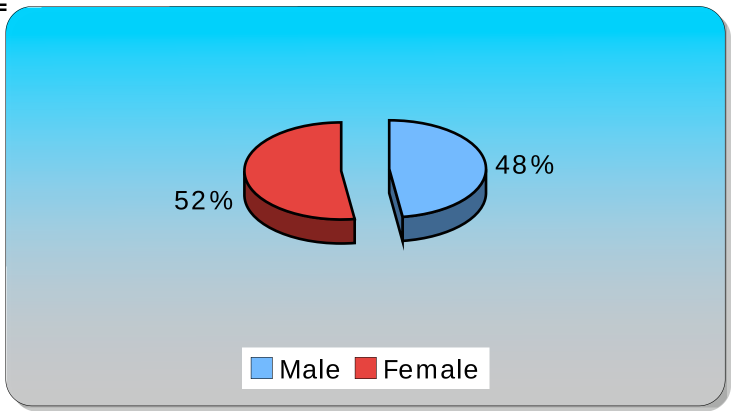
Appendix J
Mass Casualty Triage Training using Manikin Simulation

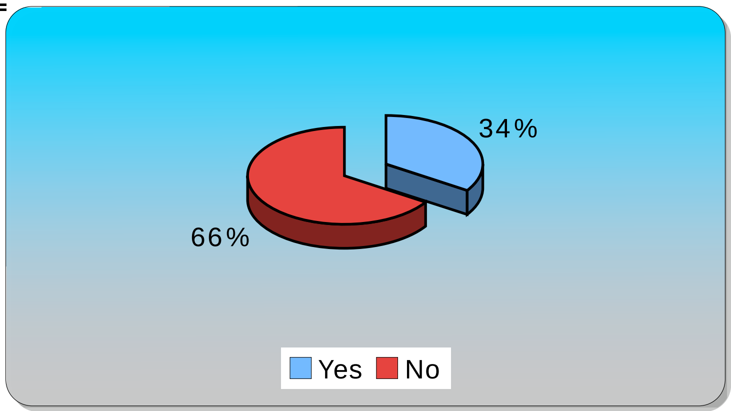
Mass Casualty Triage Training

Osaka City University - June 2007

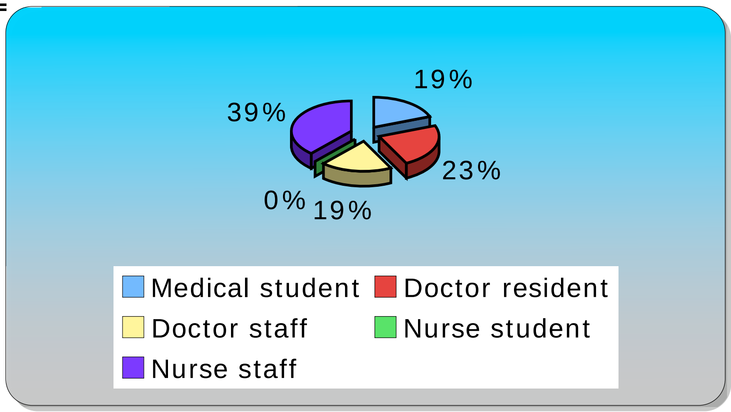
What gender are you?	Responses	
Male	21	47.73%
Female	23	52.27%
Totals	44	100%



Have you worked with a simulator like SimMan?	Responses	
Yes	15	34.09%
No	29	65.91%
Totals	44	100%

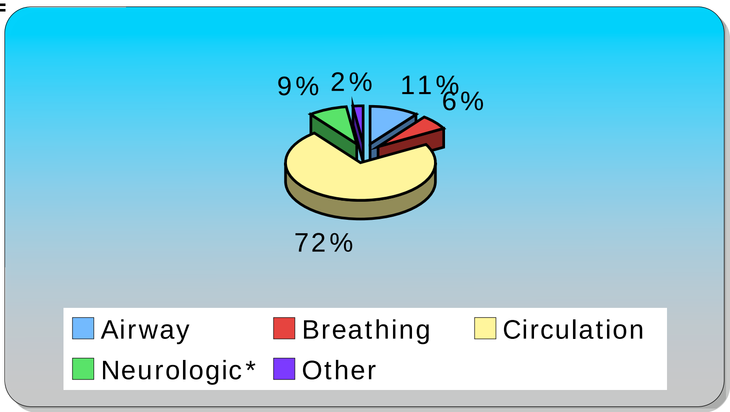


What is your job?	Responses	
Medical student	9	19.15%
Doctor resident	11	23.40%
Doctor staff	9	19.15%
Nurse student	0	0%
Nurse staff	18	38.30%
Totals	47	100%



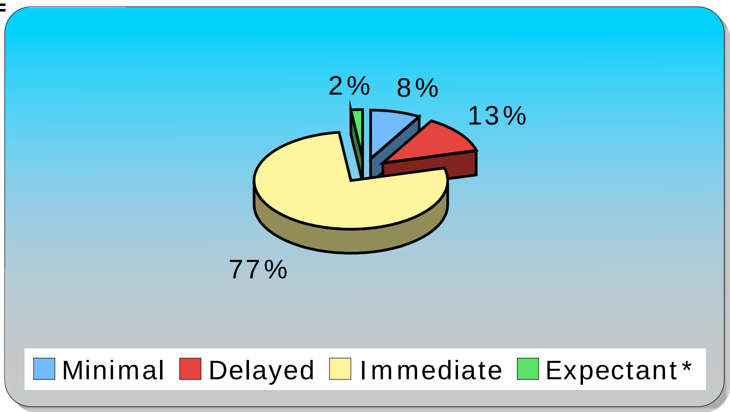
Traumatic Brain Injury Case	Responses	
Airway	5	10.64%
Breathing	3	6.38%
Circulation	34	72.34%
Neurologic*	4	8.51%
Other	1	2.13%
Totals	47	100%

*Correct Answer



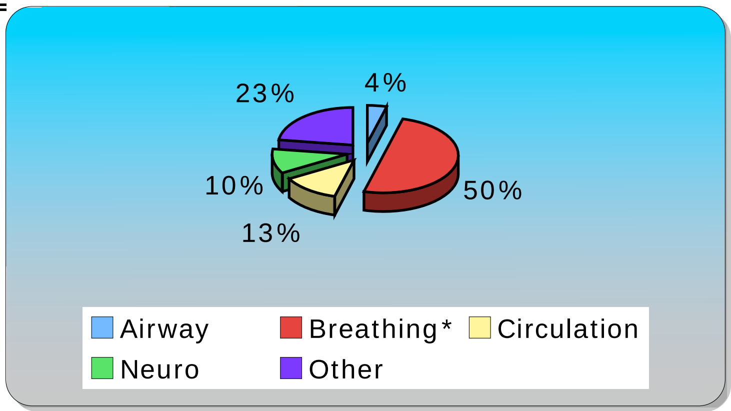
Triage Category (traumatic brain injury case)?	Responses	
Minimal	4	8.33%
Delayed	6	12.50%
Immediate	37	77.08%
Expectant*	1	2.08%
Totals	48	100%

*Correct Answer



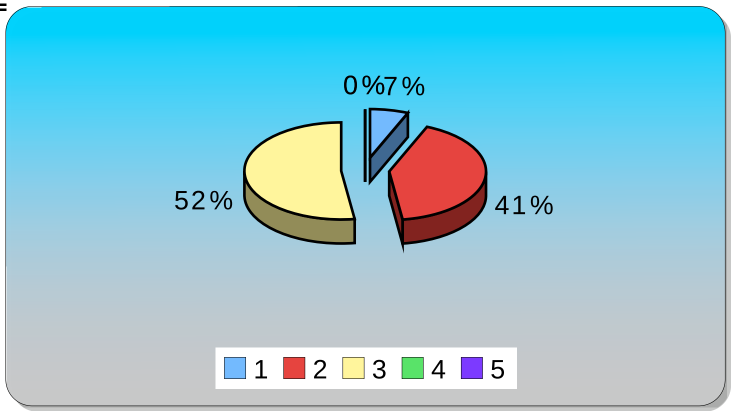
Tension Pneumothorax Case	Responses	
Airway	2	4.17%
Breathing*	24	50%
Circulation	6	12.50%
Neuro	5	10.42%
Other	11	22.92%
Totals	48	100%

*Correct Answer



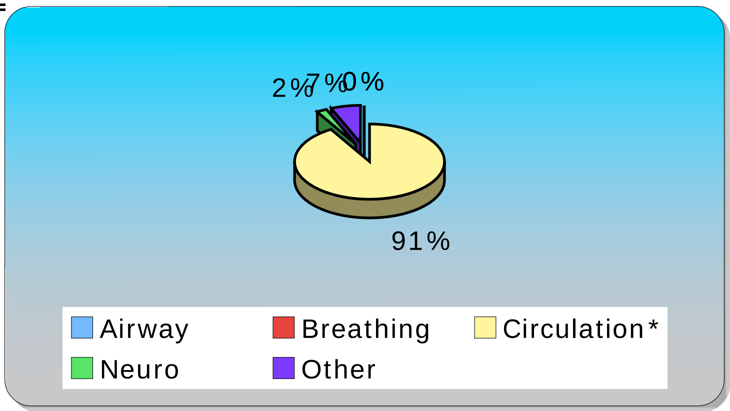
Triage Category (tension pneumothorax case)?	Responses	
Minimal	3	6.52%
Delayed	19	41.30%
Immediate*	24	52.17%
Expectant	0	0%
	0	0%
Totals	46	100%

*Correct Answer



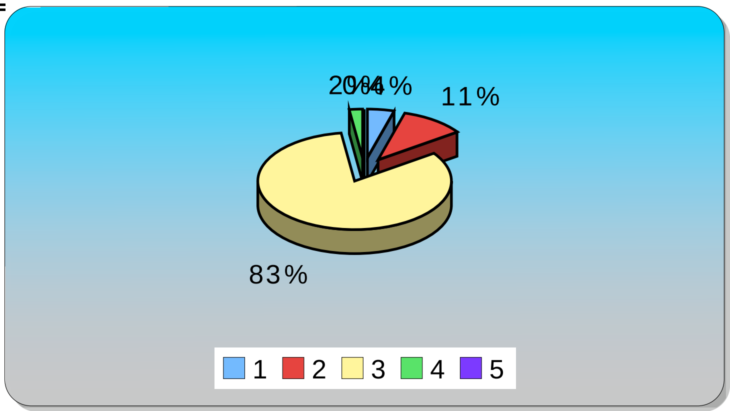
Hemorrhagic Shock case	Responses	
Airway	0	0%
Breathing	0	0%
Circulation*	42	91.30%
Neuro	1	2.17%
Other	3	6.52%
Totals	46	100%

*Correct Answer

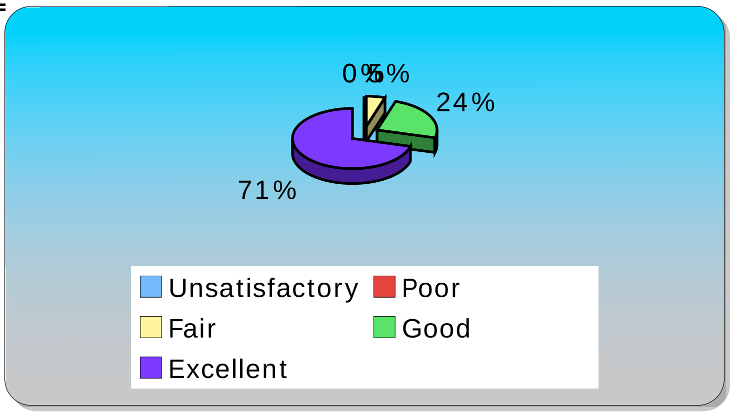


Triage Category (hemorrhagic shock case)?	Responses	
Minimal	2	4.35%
Delayed	5	10.87%
Immediate*	38	82.61%
Expectant	1	2.17%
	0	0%
Totals	46	100%

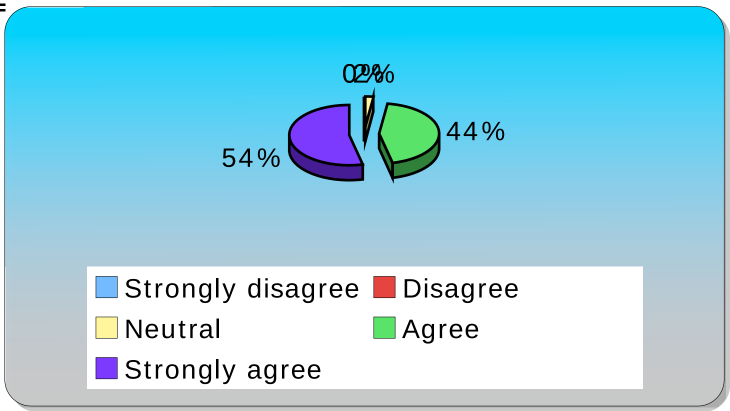
*Correct Answer



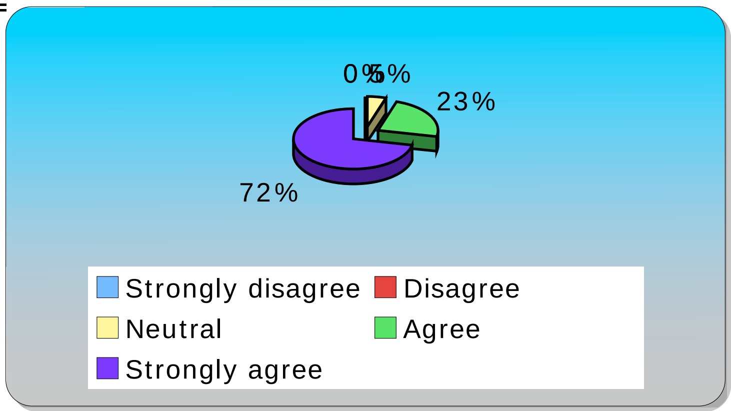
Please rate the quality of this triage course	Responses	
Unsatisfactory	0	0%
Poor	0	0%
Fair	2	4.88%
Good	10	24.39%
Excellent	29	70.73%
Totals	41	100%



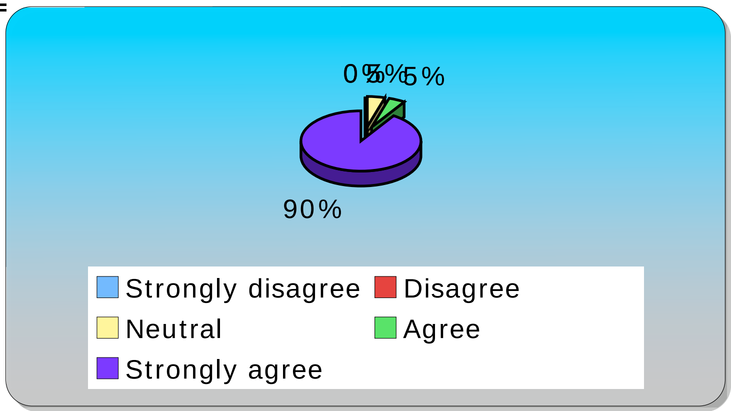
Simulation improved my understanding of mass casualty triage	Responses	
Strongly disagree	0	0%
Disagree	0	0%
Neutral	1	2.33%
Agree	19	44.19%
Strongly agree	23	53.49%
Totals	43	100%



Manikin simulation should be a regular part of mass casualty triage training	Responses	
Strongly disagree	0	0%
Disagree	0	0%
Neutral	2	5.13%
Agree	9	23.08%
Strongly agree	28	71.79%
Totals	39	100%



Learning about mass casualty triage is important for healthcare workers	Responses	
Strongly disagree	0	0%
Disagree	0	0%
Neutral	2	4.65%
Agree	2	4.65%
Strongly agree	39	90.70%
Totals	43	100%



Appendix K
Optical Sight Metaphor for Virtual Environments

Optical Sight Metaphor for Virtual Environments

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ABSTRACT

Optical sight is a new metaphor for selecting distant objects or precisely pointing at close objects in virtual environments. Optical sight combines ray-casting, hand based camera control, and variable zoom into one virtual instrument that can be easily implemented for a variety of Virtual, Mixed, and Augmented Reality systems. The optical sight can be modified into a wide family of tools for viewing and selecting objects. Optical sight scales well from desktop environments to fully immersive systems.

Keywords: Object selection, vision aid virtual tools, ray-casting.

Index Terms: H.5.1 [Information Systems]: Information Interfaces and Presentation—Artificial, augmented, and virtual realities H.5.2 [Information Systems]: Information Interfaces and Presentation—User Interfaces Input devices and strategies

1 INTRODUCTION

Object selection is a fundamental task for all systems where virtuality is involved. Dozens of methods and metaphors have been implemented for object selection and manipulation, including a 'virtual hand', a 'world-in-miniature' and a magical 'voodoo doll' (see a short survey of the most popular techniques in [1]). More methods and designs are described in [2] and their numbers are constantly growing.

Techniques based upon the 'virtual hand' metaphor became classic in the field of user interface (UI) design. The virtual hand is used to manipulate objects, steer travel direction, specify targets and perform application-specific tasks. The virtual hand metaphor has been applied for object selection by direct touching [3], extended touching [4] and, in conjunction with various forms of ray-casting, by pointing at the object [5, 6, 7]. As discussed in [6], noise and imprecision of tracking along with the instability of the user's hands make it difficult and sometimes impossible to select distant or small objects reliably. Unassisted pointing with 'bare-hands' may become a prolonged, laborious task, leading to fatigue, errors, and frustration. Also, with unassisted pointing it is problematic to select occluded or partially occluded objects. However, the simplicity and low computational cost of ray-casting makes direct pointing very attractive for building user interfaces.

A variety of techniques were proposed to improve the usability of methods based on ray-casting. The *Flashlight* metaphor by [5] reduces the need for pin-point precision in selecting objects by replacing thin rays with conic volumes. The aperture technique [6] employs cones of variable sizes, which allows users to close in on the object of interest by narrowing the cone. However, the entire object of interest must be initially covered by the pointing cone. This requirement may become problematic in situations where the object and the viewer are in close proximity. A collection of techniques described in [7] take advantage of reducing the selection problem to a 2D case. These methods use traditional ray-casting with a combination of intuitive hand positions that help aim probing rays.

In our work, the *optical sight* metaphor is introduced which complements existing methods for selecting objects that demand virtual hand and ray-casting techniques. Optical sight eliminates the problem of selecting small or distant objects by using variable camera zoom. Hand and head stabilization reduces the jitter problem. Furthermore, the optical sight metaphor provides an intuitive and flexible context for the implementation of a variety of view-enhancing interface devices.

2 OPTICAL SIGHT METAPHOR

In its basic form, an optical sight is a combination of a variable camera zoom, hand-controlled direction of view, and pin-point ray-casting. As the name implies, the optical sight is primarily intended for selecting objects by shooting, which is accomplished by firing probe rays from the eye-point in the look direction. Optical sight is a direct descendant of the family of pointing techniques that involve aiming which were described earlier. The focus of this work is to make pointing and selection easier. Therefore, we do not compare it to view enhancing virtual interfaces, such as the 3D MagicLens [10], X-Ray vision [11], and the zoom tool [8].

- *Basic model*: As in the real optical sight, the view follows the direction of the pointing hand. Zoom is fixed with head and hand tracking data unfiltered.
- *Improved model*: Zoom is variable. Hands and head tracking are stabilized by oversampling the raw data from a tracking system. The number of sub-samples varies to compensate for jitter that increases with the zoom level.
- An optional *crosshair* slides over the image plane providing an additional input stream for confirming selections. Note that the look direction and the head orientation are decoupled. While the hand is controlling the view (i.e., defines the look direction), the head rotation controls the position of the crosshair on the viewing plane (i.e., serves as a pointing device). Selection of an object is made when the object is placed at the center of the view and overlayed by the crosshair, in other worlds, is being pointed at both by the hand and the head.
- An optional *head light projector* may be attached to the optical sight in poor virtual lighting conditions and a *night vision device* may be used in virtual scenarios when users need to conceal their position.

In the models described above, the optical sight is attached to a pointing hand, which makes it more suitable for target-oriented activities. Alternatively, the optical sight may be controlled by head orientation. In this case, it behaves similar to a real world viewing device such as a binoculars, or a telescope. These devices are well suited to exploration tasks.

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Figure 1: How to operate an optical sight. "Point-at" pose (A) along with a "take a good look" pose (B) form the command pose to start the optical sight mode (C). Once the optical sight is engaged, the extended arm can relax (D). To return to normal view, the left hand is dropped (E).

3 IMPLEMENTATION

The optical sight was implemented as part of the immersive system for training triage skills *VR-Triage*, which is currently under development at the University of Hawaii School of Medicine. The user interface is based on human poses and specified by the position and orientation of the user's hands and head. Hands and head are tracked with an extended range Flock of Birds motion tracking system. The following rules describe the command interface.

The optical sight mode is initiated by extending the dominant hand at 75% of the arm's length or more ("pointing at something" pose, see Figure 1, A). The other hand must be placed above the eyebrows, palm down ("take a good look" pose in Figure 1, B). Upon detection of this combination, the command language interpreter turns the optical sight on.

In this mode, the dominant hand serves as a pointer. The selecting rays are fired from the eye-point through the center of the viewing frame continuously, with a half second frequency. In the non-immersive version of *VR-Triage*, the rays are fired using a mouse click. To make it easier for users and to minimize fatigue, the requirement to hold a pointing arm extended is dropped once the optical sight mode is initiated (Figure 1, D). While the dominant hand is driving the direction of view, the other hand controls zoom. By shifting it left and right in front of the camera, the user increases and decreases the level of magnification. This replicates the 'wide-telephoto' slider adjustment used in many camcorders. In this case, the slider is the hand moving along the X coordinate in the user's eye space, remaining in a 50 cm-proximity from the eye in the Z direction. Alternatively, the camera zoom may be intuitively controlled by using the axial rotation of the non-dominant hand. Here, pronation increases and supination decreases magnification. This method of zoom control is depicted in Figure 1, D.

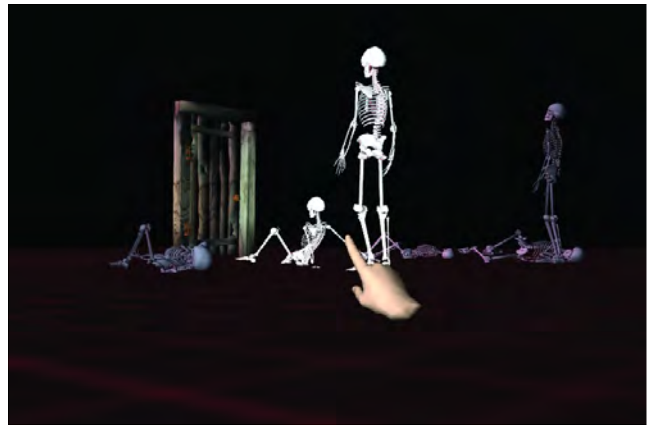
To return to the normal view, the user must move his or her hand away from the 'zoom slider' zone.

In *VR-Triage*, the optical sight is used for traveling towards distant objects. Target-based travel allows one to traverse long distances without continuous steering, which minimizes fatigue. Figure 2 shows snapshots from the training zone of *VR-Triage*, which is also used for testing various UI techniques. A view only *virtual binoculars* mode was also implemented.

To conclude this section, we reiterate that the look direction does not need to be dependent on the orientation of the head. This position only implementation allows us to use the same interface for immersive environments with either 3 DOF or 6 DOF tracking devices. For desktop monitor based implementations, it allows us to use a mouse interface. Consequently, the optical sight is fully functional in both immersive and non-immersive virtual environment applications.

4 DISCUSSION AND FUTURE WORK

In this section, we discuss additional benefits and possible extensions of the presented technique.



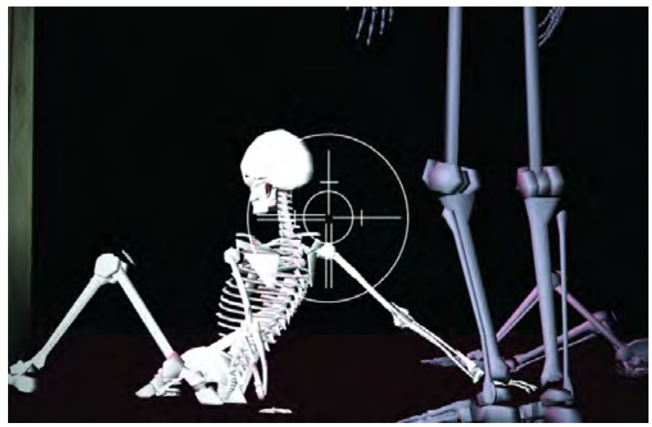


Figure 2: Selecting travel destination during travel technique practice in *VR-Triage*. Intended travel destination: sitting character. Top: normal view, multiple target selections (highlighted). Bottom: optical sight view with 4x magnification.

4.1 Mixed and Augmented Reality Applications

Optical sight was initially tested in a purely virtual environment. However, the optical sight metaphor has potential for applications in which both reality and virtuality coexist. For instance, the *Flatworld* system developed at the Institute for Creative Technologies at the University of Southern California [9] makes use of real props in conjunction with rear-projected screens displaying virtual content. In one *Flatworld* application, a real room is augmented with large virtual windows showing street scenes in a foreign country. The 3D content is very detailed and dynamic. Virtual lighting is controlled to present both day and night scenarios. Users are expected to survey the scene and react appropriately when needed to events in the environment. Simulated virtual binoculars and night vision devices based on the optical sight metaphor could play a significant role in this system. In cases when trainees are expected to return fire, the optical sight can also play a role. A basic *Flatworld* mixed reality system is shown in Figure 3.

In real life, optical sights, binoculars, and other view enhancing devices bring distant objects closer without making them more available for active interaction. In our discussion of the optical sight, it should be noted that it is very important that virtual interfaces match the user's functionality expectations. In other words, a pair of virtual binoculars must do exactly the same job as real ones. When this requirement is satisfied, incorporating interface tools such as these to virtual environments will enhance rather than distract from the user's sense of presence and engagement.

Figure 3: Here, a virtual desert scene projected on two screens is merged with the real room environment's prop window and doorframe. In this setting, a pair of binoculars could be useful for surveying the scene. View magnification on the screen could be triggered when the user picks up a pair of tracked, real binoculars, looks through them, and views the scene presented via the mixed reality 'window'.

4.2 X-Ray Vision

X-ray vision can be implemented by enabling transparency on rendered objects that are hit by the pointing rays. Traversal must stop when opacity reaches a certain threshold. By adjusting the value of this threshold the viewer can effectively modulate the level of x-ray vision. This feature addresses the problem of finding and selecting occluded objects.

4.3 Natural LOD control

Another application of the optical sight is to use it as a level of detail trigger. The action of changing view zoom level could be used to switch between 3D models of low and high geometric complexity, bypassing more computationally expensive methods of geometric and visual blending.

Allowing users to observe remote parts of the scene with the same level of visual detail removes the need to stage scenario events in the immediate vicinity of the user. This feature makes the entire immersive experience more natural and more effective in training applications.

4.4 Precise Pointing at Small and Occluded Objects with the Optical Sight

In many VR systems, bounding volumes of various types are used for ray-object intersection tests. These tests are required for object selection. When high precision pointing is necessary, it is necessary to go beyond simple ray-sphere or ray-box intersections. Instead, the ray must be tested with all of the target object's polygons. There are a variety of methods for organizing geometry to accelerate ray-object intersection tests. We argue that there may be no need for these tests when using the optical sight, as the number of probing rays required for successful selection is determined primarily by human reaction time and is likely to be in the range of few rays per second.

Interestingly, increasing pointing precision for the optical sight may lead to unwanted results. Consider the characters shown in Figure 2. Polygon-level precision will result in many misses in the rib-cage area when probing rays pass between the ribs. In this case, bounding boxes are more suitable.

Considering these issues, view magnification coupled with x-ray vision may provide an optimal solution for selecting distant, small, and occluded objects with the optical sight.

4.5 User Evaluation

In our future work we plan to conduct a user study for the optical sight metaphor. In this study, the optical sight implementations mentioned in section 3 would be evaluated against comparable, established interface techniques. Additional calibration will help to find comfortable positions for zoom controls and zoom range.

5 Conclusions

We have described the design and implementation of the optical sight, a new metaphor for viewing and selecting objects in virtual scenes. We believe that this technique along with its variations will become a useful addition to existing interfaces and will hopefully encourage the development of new ones.

6 Acknoledgements

We wish to thank Ivan Poupyrev at Sony CSL for his help, advice and encouragement. The *Flatworld* project described in this paper was developed with funds of the Department of the Army under contract number DAAD 19-99-D-0046. The opinions, findings, conclusions, or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the sponsors.

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Appendix L
Assessing the Real-Time Cognitive Capabilities of First Responders Using Emerging Technologies in Manikin Simulators (presentation)

Assessing the Real-Time Cognitive Capabilities of First Responders using Emerging Technologies in Manikin Simulators

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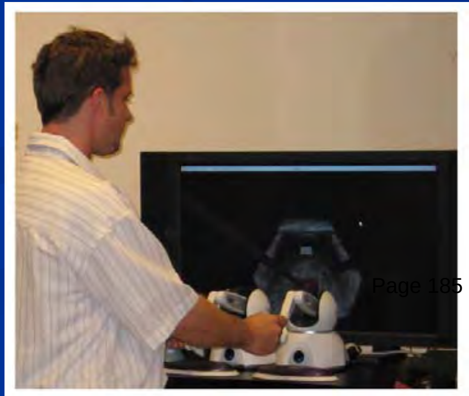
Telehealth Research Institute

Telehealth Research Institute

- SimTiki Simulation Center
  - Advanced Manikin Simulation
  - Education and Training
  - Immersive Virtual Reality
  - Surgical Simulation
- Advanced Healthcare Technology Research
  - Diabetes
  - Electronic ICU
  - Extracorporeal Membrane Oxygenation (ECMO)
  - Home Healthcare
  - Simulation
  - Telemedicine



Medical Triage

- "Trier" to sort or to choose
- Goals
  - Prioritizing patients according to severity of injury
  - Prevent further injury or death
- Nondisaster—best care for individual
- Mass casualty/disaster – best care for greatest number of patients

Mass Casualty Situations

- Larger the number of victims on the scene, the more difficult it becomes to determine the order of those that need to be treated
- Treatment of population versus individual
  - Number and types of causalities
  - Available resources
  - Atypical from normal trauma management, where each individual victim is treated

Challenge of Triage

- Challenge of medical triage is the ability to identify those that need immediate care from those that are less critically injured in a timely manner
- Performance may suffer when first responders are overwhelmed by multiple demanding tasks in stressful and volatile situations
- Training is necessary for first-responders to be able to cognitively act in the most optimal way, minimizing casualties and maximizing outcomes

Simulation Training

- Few opportunities to train
- Concern for patient safety
- Readily available cognitive and procedural training platform
- Safe and controlled environment

Manikin Simulation

- Simulate human physiology realistically
  - Breathing
  - Heart
  - Talking
  - Bowl sounds
- Haptic Feedback - Pulses
  - Palpable bilateral dorsalis pedis
  - Posterior tibialis
  - Carotid pulses

Manikin Simulation

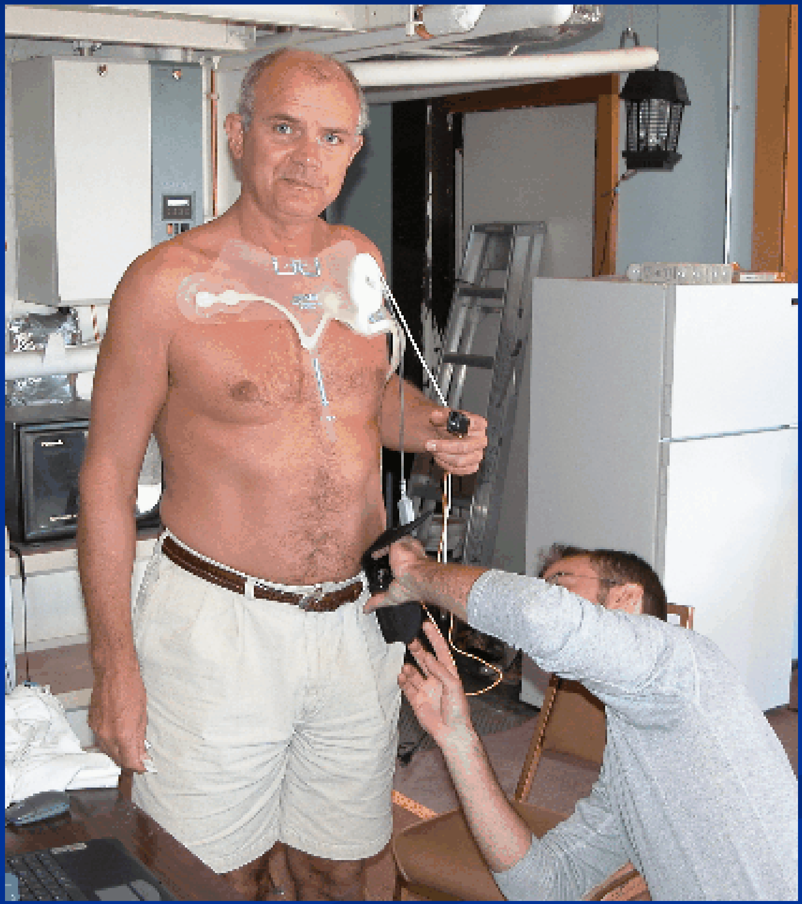
- Programmable scenarios
- Programmable trends
- On-the-fly programming
  - Vital sign parameters
    - Heart rate
    - O2 Saturation
    - Arterial blood pressure

Mitigating Augmented Cognitive Strategy for Training Triage

- Cognitive overload due to stress
- Learning and performance is negatively impacted

Physiologic Sensors

Biosensor Measure	Cognitive State
Skin Conductivity	Arousal
Peripheral Temperature	Relaxation
Heart Rate	Stress
Pupil size	Fatigue
Eye Tracking	Difficulty or stress



Scaffolding

- Controlled guidance
- Improved learning

The End

Appendix M
Assessing the Real-Time Cognitive Capabilities of First Responders Using Emerging Technologies in Manikin Simulators (paper)

Assessing the Real-Time Cognitive Capabilities of First Responders Using Emerging Technologies in Manikin Simulators

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Abstract. Medical triage can be a highly stressful situation in which decisions and task performance may have life or death consequences. Individual responses in stressful situations may affect task performance. Increased injury or casualties may occur without proper training and competency of the first-responder. The emerging technologies of advanced manikin simulators have afforded anatomic, physiological, and pharmacologic realism, which can be dynamically programmed in real-time. This has increased the capabilities and realism of manikin simulations, thus allowing advanced learning techniques that were not previously possible. By employing physiological measures of the learner to determine areas of overwhelming task complexity, which may degrade performance, a method such that the training can be adjusted to the real-time cognitive needs/load of the learner (*adaptive scaffolding)* can be applied. This has the potential to enhance learning and human data processing in medical triage training.

Keywords: Triage, manikin simulators, first-responder, physiological sensors, adaptive scaffolding.

1 Introduction

Medical triage is the act of prioritizing patients according to severity of injury in order to prevent further injury or death. In mass casualty situations, the nature and pace of the workload may vary depending on the scale of the event. First-responders must be able to process information and act accordingly in order to optimize medical and logistical outcomes. The leading challenge of medical triage is the ability to identify those that need immediate care from those that are less critically injured in a timely manner [1]. Performance may suffer when first responders are overwhelmed by multiple demanding tasks in stressful and volatile situations. Hence training is necessary for first-responders to be able to cognitively act in the most optimal way, minimizing casualties and maximizing outcomes.

D.D. Schmorrow, L.M. Reeves (Eds.): Augmented Cognition, HCII 2007, LNAI 4565, pp. 314–322, 2007.

Instructional theories suggest that learning based on real-life tasks helps the learner to integrate the knowledge and skills necessary to be able to perform the task in real life [2]. Emerging technologies of advanced manikin simulators with anatomic, physiological, and pharmacologic realism have increased the capabilities and realism of trauma simulations. Now more widely available and accessible, these advanced technologies in manikin simulators are facilitating the ability to provide advanced cognitive training in areas of acute care medicine, including medical triage, which was not previously possible.

Currently available technology in manikin simulations allows the modeling of complex physiological functions that have the ability to be dynamically programmed on-the-fly. By employing physiological sensors to monitor the human trainee, medical triage learning tasks which cause cognitive overload or overwhelming task complexity can be detected in real-time [3]. Cognitive overload or overwhelming task complexity can cause stress and may degrade performance and learning effectiveness. Using this information, a training methodology, referred to as adaptive scaffolding, can then be applied to adjust the state of the manikin to achieve optimal levels of performance and learning. This mitigation strategy has the potential to improve learning and enhance real-life performance, which may not be achieved by traditional didactic or scenario-based training alone.

2 Background

In mass casualty or trauma events, triage is an area where decision-making is vital for achieving positive outcomes; the larger the number of victims on the scene, the more difficult it becomes to determine the order of those that need to be treated. To add to the complexity, in a mass casualty situation, there must be a balance between treatment of the population versus treatment of the individual. Decisions that determine the outcomes of the greater good must be analyzed and carefully weighed, which may result in degrading the medical needs of particular individuals. This is largely based on the number and types of causalities and the available resources. Consequently some victims may not be treated despite the possibility of preventing death or further injury. This decision-making process is atypical from normal trauma management, where each individual victim is treated. Hence, mass casualty trauma situations must require advanced training and planning which are crucial in saving lives and reducing further injury [1].

2.1 The Need to Train First-Responders

Despite that it is vital that first responders and medical personnel are thoroughly trained and prepared for action, there are few opportunities to obtain the training and experience necessary for optimal performance specifically in mass casualty emergency situations. In particular, surgical residents, who are critical in emergency medical situations, lack the training necessary for mass casualty, triage and emergency medicine. Medical training must be expanded to include triage training, especially for surgeons since they are often expected to take lead roles in mass casualty events [4]. The vast number of civilian emergency personnel (150,000 emergency medical technicians and 1.7 million fire fighters) that can benefit from such training must also be underscored. The Federation of American Scientists (FAS) report in 2003, *Training Technology Against Terror: Using Advanced Technology to Prepare America's Emergency Medical Personnel and First Responders for a Weapon of Mass Destruction Attack* [5], found that the U.S.' need for first responder training was dramatically larger than previously recognized. There are over 150,000 emergency medical technicians and 1.7 million firefighters in the U.S. who would be expected to use complex critical thinking skills, such as triage, as part of incident management teams

In light of potential terrorist attacks, civilian populations of first responders and local trauma centers may not be equipped to handle the emotional, logistical and medical load that such an event may present. The military is probably the most trained for mass casualty situations, however, performance and health care of the fighting force has become increasingly challenging. A high operational pace with frequent deployments shortens training time even more. On the battlefield, in command and control situations, it is essential to assess, triage, and treat medical emergencies accurately, proficiently and in a timely manner. This task is made more difficult in stressful battlefield environments where victims may be scattered over distances in foreign, austere terrain with active gunfire.

Physicians have traditionally depended on bedside teaching to impart knowledge to trainees. This concept has become less popular because of concern over patient safety, as well as it being difficult to have a representative patient available for each diagnosis. The desire to use simulation in training whenever possible is important, as patients are protected instead of being commodities in training [6]. As such, simulation training provides an important and well-recognized bridge between the textbook and the bedside, and should be utilized whenever possible.

2.2 Overview of Manikin Technology

Simulation technology can provide a solution for the need to train triage by providing readily available cognitive and procedural training platforms that can supplement a didactic triage curriculum. In addition to skills training, simulation exercises can help lower psychological barriers in stressful emergency situations by providing a safe and controlled environment for practice [7].

Manikin based simulations have been mainstays in medical education for many years [8]. Less advanced manikins are utilized in certification courses such as Cardio-Pulmonary Resuscitation (CPR) and Basic Life Support (BLS). Advanced manikin simulation technologies, which are computer driven, can simulate a multitude of real-life medical scenarios. These advanced manikins are currently being used to train Acute Trauma Life Support (ATLS), Pediatric Advanced Life Support (PALS), as well as, other acute medical emergences, such as hemmorhagic shock or tension pneumothorax. Manikin simulation technology provides the opportunity for students to practice routine, complex or unusual medical procedures in a controlled environment without risk to patients. The software that drives the simulations is interactive and offers real-time feedback to interventions, allowing students to be immediately assessed. A debriefing session allows students to repeat scenarios to enforce learning.

Advances in manikin technology have enabled the ability to simulate human physiology realistically, interactively and with the ability to preprogram or dynamically program the scenerios. The SimMan™ manikin simulator physiological features include breathing, talking, heart, breath and bowel sounds. In addition, haptic feedback features include palpable bilateral Dorsalis Pedis, Posterior Tibialis and carotid pulses. Radial and brachial pulses are available on the left arm, while the right arm may be cannulated for IV and blood work procedures. Airway management procedures include bag-valve-mask ventilation, supraglottic airway adjuncts, endotracheal intubation and cricothyrotomy. Pupils may be modified for assessment. The trauma module for SimMan™ includes interchangeable parts to simulate fractures, burns, impaled objects, and projectile entry/exit wounds [9].

Another advanced feature of manikin simulators is the ability to be dynamically programmed, in real-time, via a wireless laptop computer. An instructor can manipulate the manikin physiology and initiate physiological trends, while students are simultaneously assessing and treating the manikin. This includes vital signs parameters, such heart rate, O2 saturation, arterial blood pressure, pulmonary artery pressure, end tidal CO2, respiratory rate and blood pressure. Trends that occur over time can also be preprogrammed and dynamically initiated. This includes the aforementioned vital signs and central line monitoring such as central venous, pulmonary artery and wedge pressures, and cardiac output.

Fig. 1. SimMan™ manikin simulator and laptop computer, which controls the manikin via wireless technology

These advanced emerging manikin capabilities afford the ability for dynamic and interactive simulations of real-life physiological states, changes in states and complex medical scenarios, which can be used to train first-responder, medical and allied health students and health professionals. The realism and ability to conduct complex cognitive tasks on a virtual patient has the potential to be a valuable learning platform.

3 Mitigating Augmented Cognitive Strategy

Medical triage can be a highly stressful situation in which decisions and task performance may have life or death consequences. Individuals may vary in their cognitive capabilities depending on factors the may include expertise, experience, stress, fatigue, distractions, or other internal psychological states. Cognitive overload and stress caused by individual responses may negatively affect and degrade task performance. An intervention of using physiological sensors can be used to determine areas of overwhelming task complexity which may affect performance [3]. Using this information, an individual mitigation strategy of scaffolding can be used to manage and recognize areas of difficulty in order to enhance learning and human data processing by adjusting learning to the individual cognitive needs of the learner [10].

3.1 Assessment of Cognitive State Using Physiological Measures

Cognitive Load Theory (CLT) assumes that the human working memory has a limited capacity. When humans are tasked to the maximum, overload occurs in which learning and performance is degraded. Accordingly reducing cognitive load to accommodate better learning can be more effective in the transfer of performance to real world tasks. Research has also confirmed that emotional influences play a vital role in cognitive processing, such as relationships between anxiety and attention, or emotional state and memory [11].

In addition to the existing cognitive state, learners have difficulty integrating knowledge due to cognitive overload by the complexity of the task. In a study conducted by Crosby and Ikehara (2006) physiological measures of eye tracking, heart rate, electrodermal activity, finger temperature and pressure applied to a computer mouse was used to determine physiological responses to a task with increasing difficulty. The results showed that anomalous individual physiological responses to tasks can be detected, which may affect performance in critical situations [3]. This information can then be used to individually adjust training to allow for improved task proficiency.

In managing cognitive load, to achieve optimal learning, the presentation of learning material cannot alone determine that the learner is assimilating information optimally. It is desireable that cognitive resources be balanced between two type of cognitive states. These are external cognitive load, which may be adequate instructional materials, and on the individual learners internal cognitive load or strategies in dealing with the task [12]. Non-invasive physiological sensors can measure and help detect the cognitive state of the learner in real-time during task performance. The advantages to using physiological measures, versus measurements of speech, facial expressions, body language, or self-reporting, are that they are functions of the human autonomic system that are difficult to falsely generate and can be detected in real-time. With the availability of commercially available wearable sensors, emotions, such as stress can be detected. Table 1 describes some of the non-evasive physiological measures that can be used to determine stress related emotions while training triage.

Table 1. Biosensor Measures that can Determine Cognitive State [13]

Biosensor Measure	**Cognitive State**
Skin Conductivity	Arousal
Peripheral Temperature	Relaxation
Heart Rate	Stress
Pupil size	Fatigue
Eye Tracking	Difficulty or stress

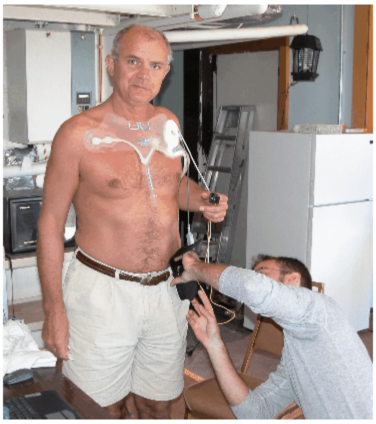

Fig. 2. Example of noninvasive physiological sensors (Nexan Ltd.), which can transmit data wirelessly via an attached PDA. Measures 2-lead electrocardiogram, pulse oximetry, heart rate, respiration rate and temperature.

3.2 Scaffolding as a Mitigation Strategy

Once cognitive overload is detected, a mitigation strategy of scaffolding can be used in enhancing triage training. The concept of scaffolding is based on the developmental theories of Vygotsky (1978) [14]. The concept is based on the theory that with controlled guidance of an expert or teacher, higher levels of thinking can be achieved. Scaffolding can supplement affective (emotional) strategies and create a context in which active exploration of ideas is encouraged [15]. Studies using scaffolding in hypermedia have shown significant increases in student's learning as indicated by performance, understanding, the ability to process data. Results showed higher conceptual understanding than those learning without scaffolding [16]. In a study using computer based scaffolding to design and simulate clinical trials, students were able to demonstrate a 34% increase in the number of elements they included in their research proposals. Also, the students were able to improve their critiques of flawed proposals by 48% [17].

Based on the concept of scaffolding, *adaptive scaffolding* is the idea that task difficulty can be adjusted based on the individual learners level of ability. In other words, simulated tasks can be restructured dynamically to improve understanding in particular topics [18]. This can facilitate the student's success in the task beyond their current capability, similar to the idea of adaptive learning. It is important to note that, in accordance with CLT, learners should be exposed fully to the task at hand. Breaking up a task may cause increased cognitive load due to the need to piece together and reintegrate the information [19].

Applying scaffolding to training triage has the potential to improve cognitive skills. It is critical to be able to determine the when and how much to adjust the cognitive load, thus helping, and not hampering, the learner. This is can be accomplished by the feed back of physiological sensors to detect moments of cognitive overload or stress. When the learner is overwhelmed by the task situation, the instructors can dynamically program the manikin to either maintain or change physiological state, giving the user time to reassess and internally process information. This mitigating strategy may provide a learning environment where information may be processed and stored in a more optimal fashion than traditional training.

4 Conclusion

This paper has focused on the use of advanced manikin simulators and physiological sensors as a potential tools to enhance human learning performance. Emerging technologies in manikin simulators has opened the door to new methods of training, learning and assessment that were not available a few years ago. Advances in human-computer interaction are evolving in such a way that learning activities are no longer constrained by the limitation of technology. Employing methods such as adaptive scaffolding in conjunction with physiological measures of learner stress has the potential to optimize learning. The student can be given "just-in-time" training assistance (learners are able to access information when they need it) so that they can learn and integrate knowledge more effectively than previously possible.

In accordance with the Defense Advanced Research Projects Agency (DARPA) Augmented Cognition Program, employing the emerging technologies of manikin simulation and physiological sensors to detect and augment the training of medical triage has the potential to increase the effectiveness and improve the transfer of knowledge to real-life situations. This is facilitated by the ability to manipulate training based on the individual's cognitive capacity and in turn, improve the mental processes and performance of the trainee. At a disaster site, triage may be the most important medical task performed [20]. The ability to optimally train first-responders in a realistic and safe environment in conjunction with adaptive scaffolding optimized for the individual student's cognitive processing can be of great value.

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19. Kalyuga, S., Chandler, P., Sweller, J.: Managing split-attention and redundancy in multimedia instruction. Applied Cognitive Psychology 13(4), 351–371 (1999)
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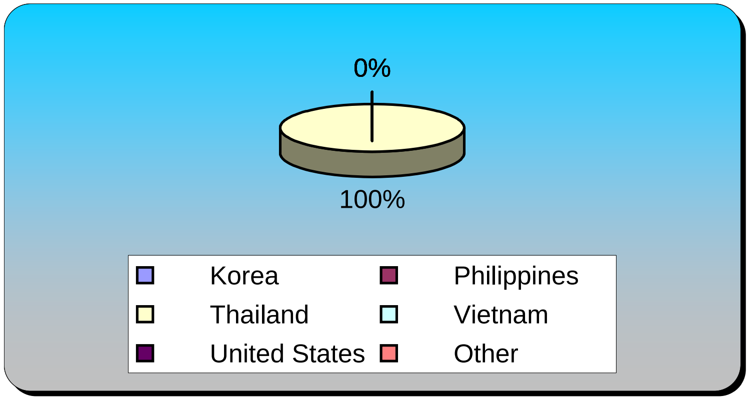
Appendix N
Asia Pacific Nursing Forum Workshop Results

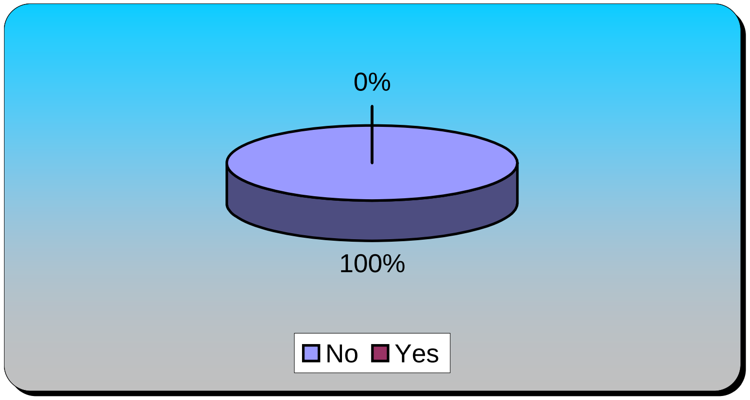
Turning Graphical Results by Question

Session Name: Asia Pacific Nurses session 1 8-15-2007 2-20 PM.tpz
Created: 8/15/2007 4:16 PM

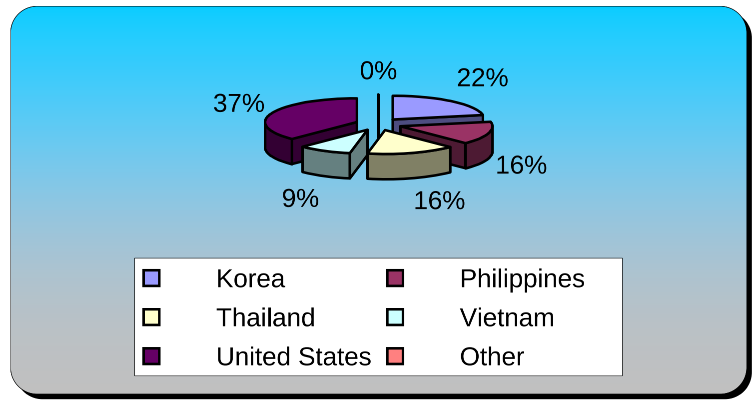
1.) My country is	Responses	
Korea	0	0%
Philippines	0	0%
Thailand	1	100%
Vietnam	0	0%
United States	0	0%
Other	0	0%
Totals	**1**	**100%**



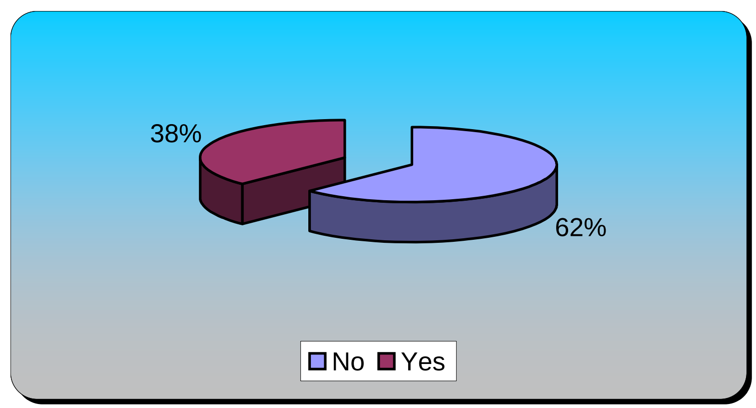
2.) Have you used Mr.SimMan before?(or someone like SimMan)	Responses	
No	1	100%
Yes	0	0%
Totals	**1**	**100%**



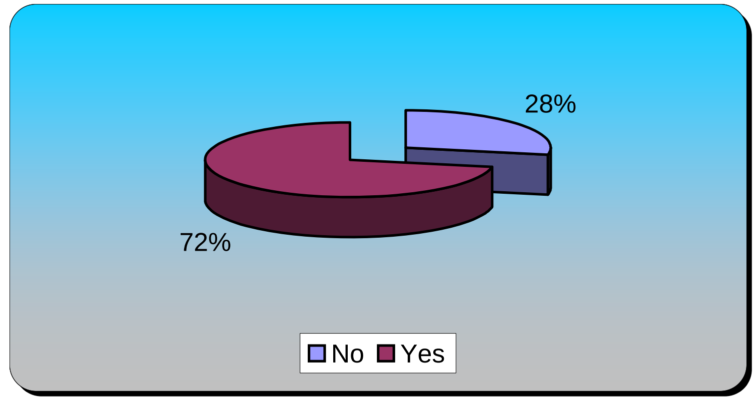
3.) My country is	Responses	
Korea	7	21.88%
Philippines	5	15.62%
Thailand	5	15.62%
Vietnam	3	9.38%
United States	12	37.50%
Other	0	0%
Totals	**32**	**100%**



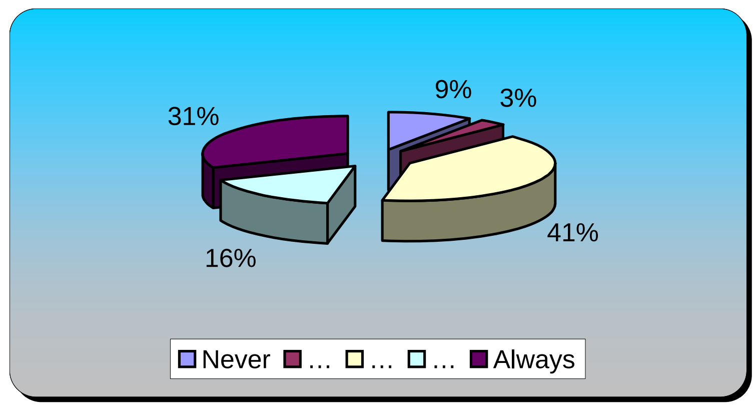
4.) Have you used Mr.SimMan before?(or someone like SimMan)	Responses	
No	20	62.50%
Yes	12	37.50%
Totals	**32**	**100%**



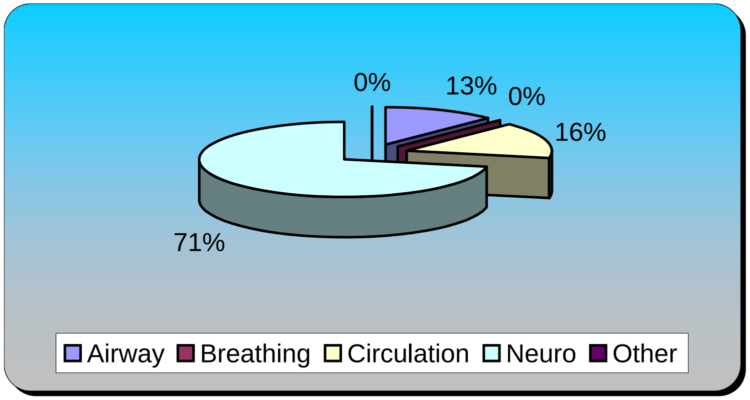
5.) Do you know how to do mass casualty	Responses	
No	9	28.12%
Yes	23	71.88%
Totals	**32**	**100%**



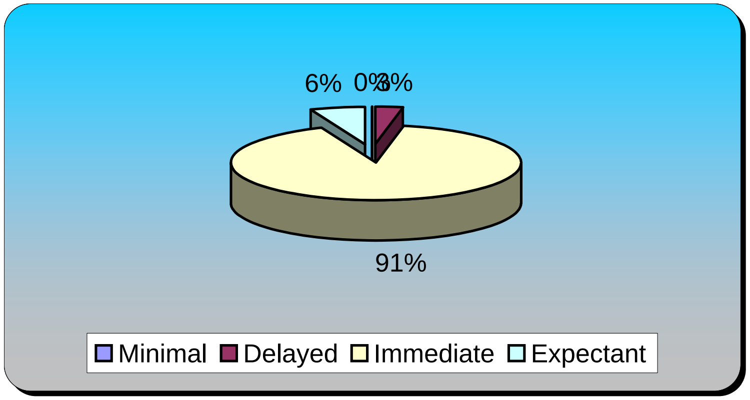
6.) I feel confident doing mass casualty triage.	Responses	
Never	3	9.38%
…	1	3.12%
…	13	40.62%
…	5	15.62%
Always	10	31.25%
Totals	**32**	**100%**



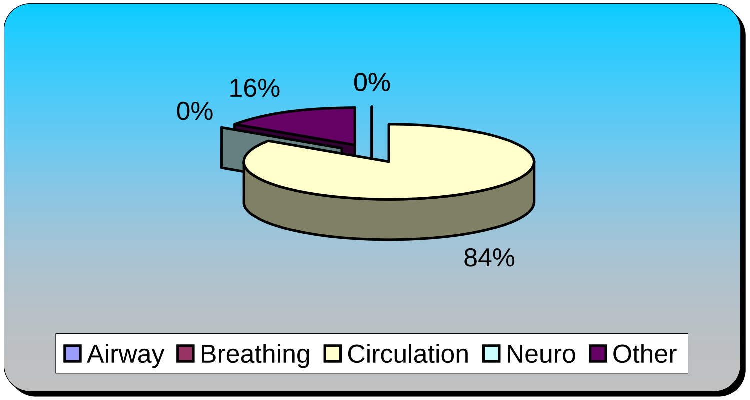
7.) Please make your selection...	Responses	
Airway	4	12.50%
Breathing	0	0%
Circulation	5	15.62%
Neuro	23	71.88%
Other	0	0%
Totals	**32**	**100%**



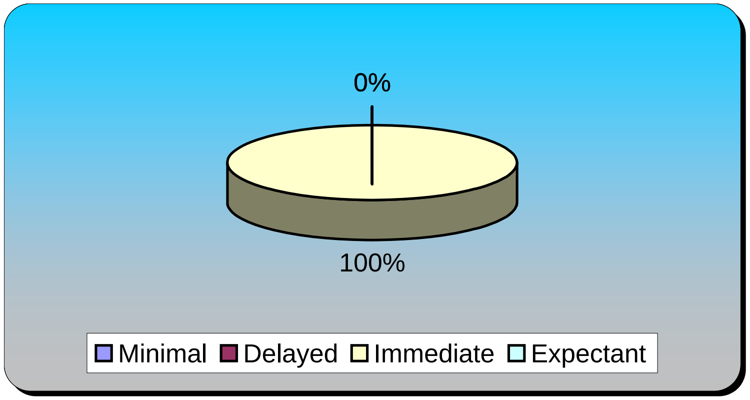
8.) Triage category?	Responses	
Minimal	0	0%
Delayed	1	3.12%
Immediate	29	90.62%
Expectant	2	6.25%
Totals	**32**	**100%**



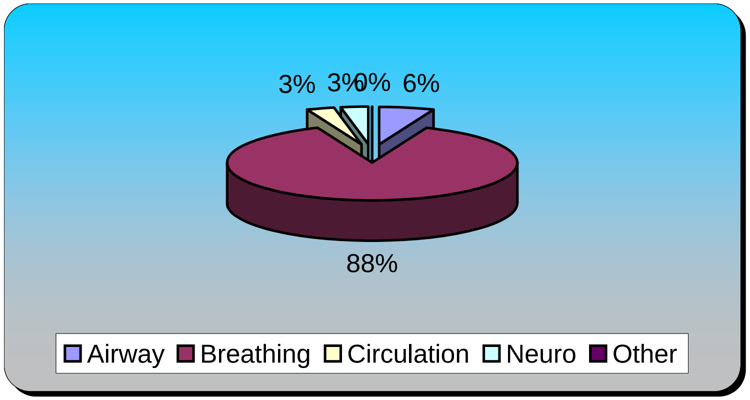
9.) Please make your selection...	Responses	
Airway	0	0%
Breathing	0	0%
Circulation	27	84.38%
Neuro	0	0%
Other	5	15.62%
Totals	**32**	**100%**



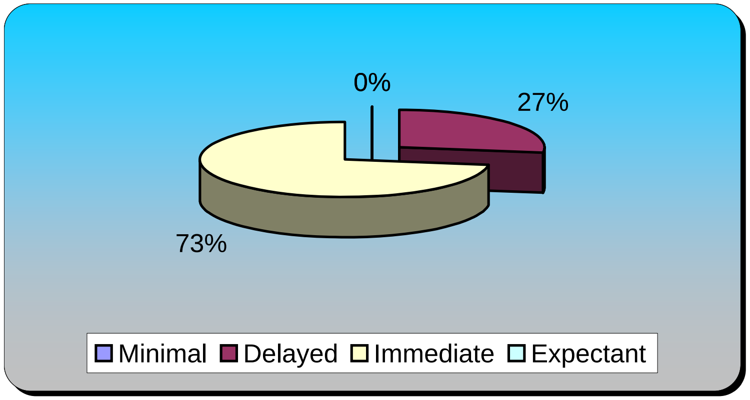
10.) Triage category?	Responses	
Minimal	0	0%
Delayed	0	0%
Immediate	32	100%
Expectant	0	0%
Totals	**32**	**100%**



11.) Please make your selection...	Responses	
Airway	2	6.06%
Breathing	29	87.88%
Circulation	1	3.03%
Neuro	1	3.03%
Other	0	0%
Totals	**33**	**100%**

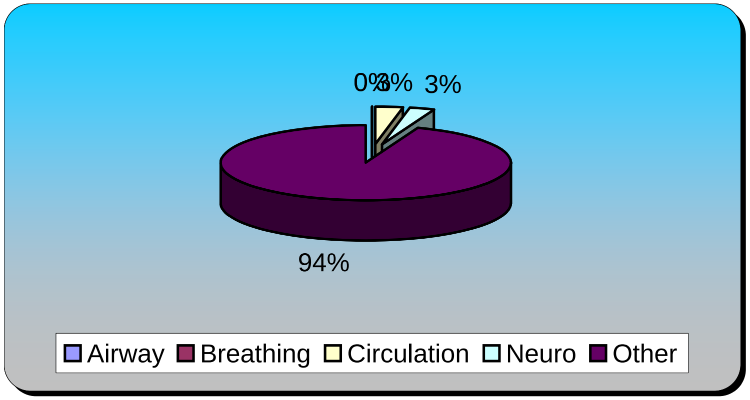


12.) Triage category?	Responses	
Minimal	0	0%
Delayed	9	27.27%
Immediate	24	72.73%
Expectant	0	0%
Totals	**33**	**100%**

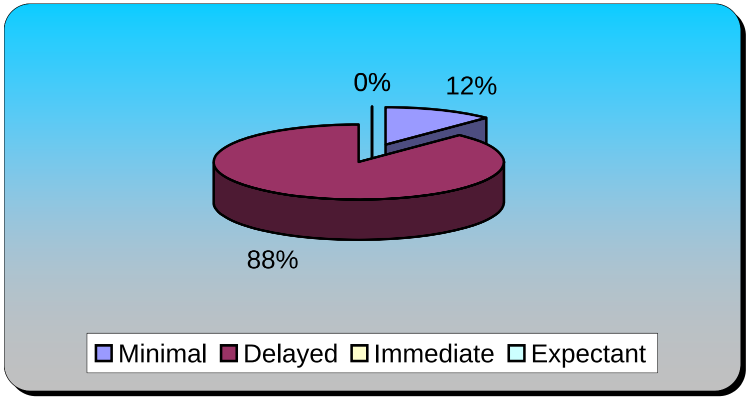


13.) Please make your selection...	Responses

Airway	0	0%
Breathing	0	0%
Circulation	1	2.94%
Neuro	1	2.94%
Other	32	94.12%
Totals	**34**	**100%**

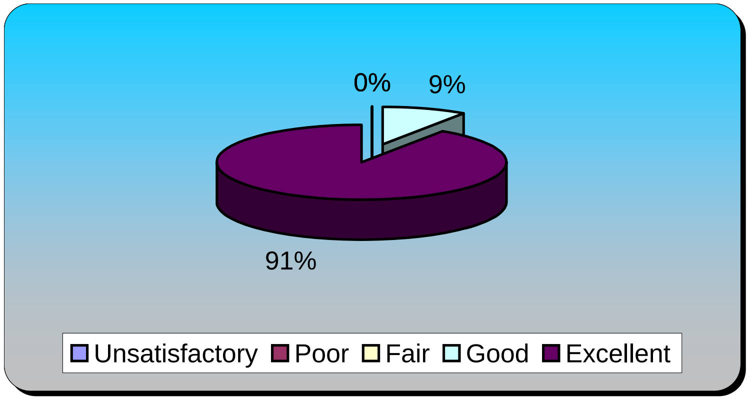


14.) Triage category?	**Responses**	
Minimal	4	12.12%
Delayed	29	87.88%
Immediate	0	0%
Expectant	0	0%
Totals	**33**	**100%**

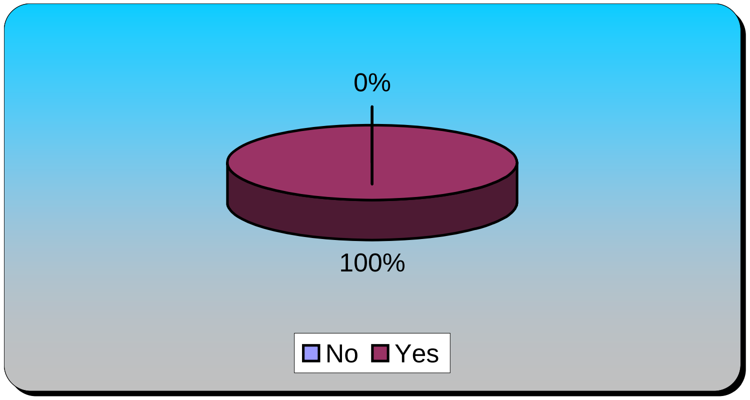


15.) This class was:	**Responses**

Unsatisfactory	0	0%
Poor	0	0%
Fair	0	0%
Good	3	9.38%
Excellent	29	90.62%
Totals	**32**	**100%**



16.) Do you know how to do mass casualty	Responses	
No	0	0%
Yes	32	100%
Totals	**32**	**100%**



17.) I feel confident doing mass casualty triage.	Responses	
Never	0	0%

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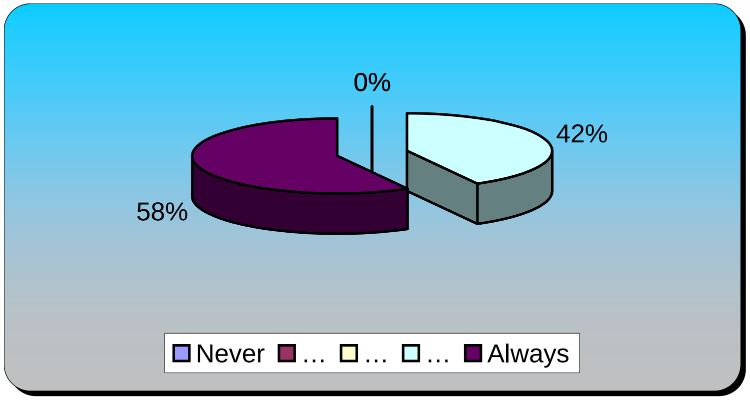
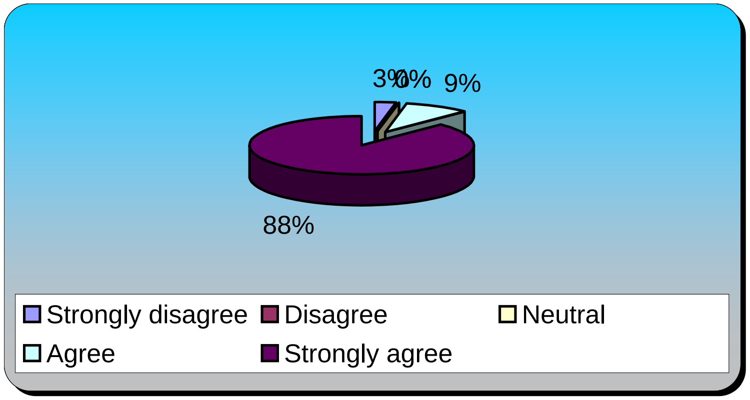
…	0	0%
…	0	0%
…	13	41.94%
Always	18	58.06%
Totals	**31**	**100%**

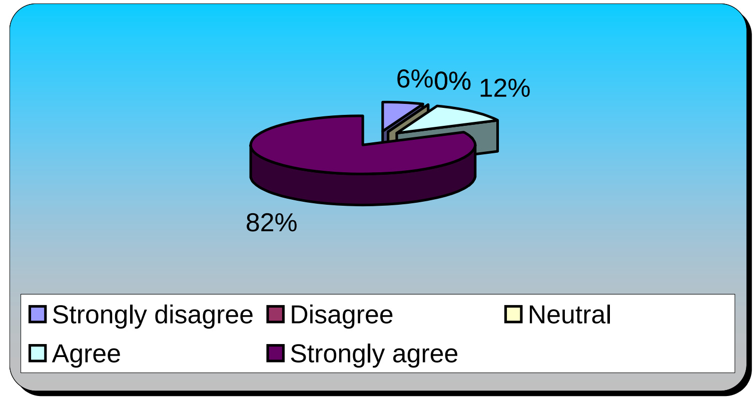


18.) Simulation improved my understanding of mass casualty triage.	Responses	
Strongly disagree	1	3.12%
Disagree	0	0%
Neutral	0	0%
Agree	3	9.38%
Strongly agree	28	87.50%
Totals	**32**	**100%**

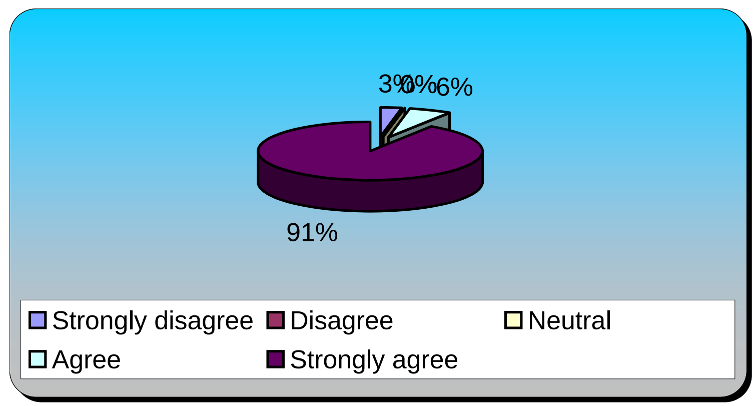


19.) Simulation should be a regular part of mass casualty triage training	Responses

Strongly disagree	2	5.88%
Disagree	0	0%
Neutral	0	0%
Agree	4	11.76%
Strongly agree	28	82.35%
Totals	**34**	**100%**



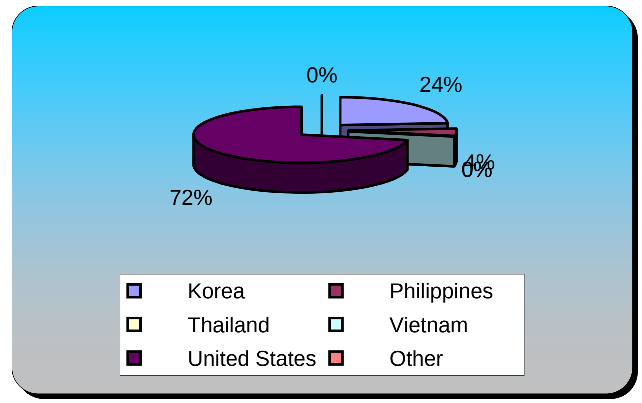
20.) Learning about mass casualty triage is important for nurses	**Responses**	
Strongly disagree	1	3.03%
Disagree	0	0%
Neutral	0	0%
Agree	2	6.06%
Strongly agree	30	90.91%
Totals	**33**	**100%**



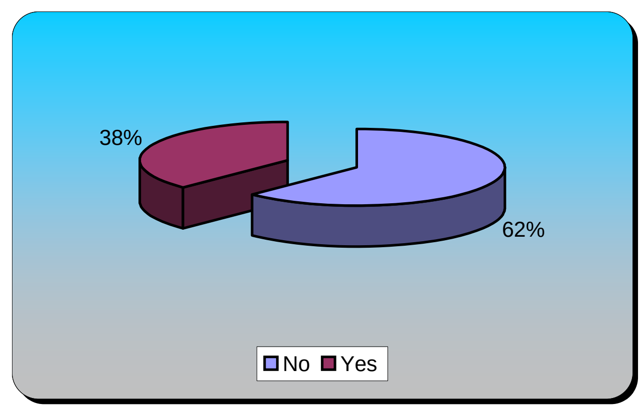
Turning Graphical Results by Question

Session Name: Asia Pacific Nurses session 2 8-15-2007 4-08 PM.tpz
Created: 8/15/2007 4:14 PM

1.) My country is	Responses	
Korea	6	24%
Philippines	1	4%
Thailand	0	0%
Vietnam	0	0%
United States	18	72%
Other	0	0%
Totals	**25**	**100%**

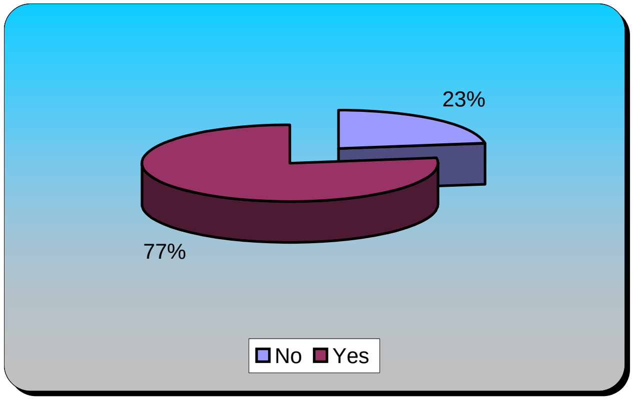


2.) Have you used Mr.SimMan before?(or someone like SimMan)	Responses	
No	15	62.50%
Yes	9	37.50%
Totals	**24**	**100%**



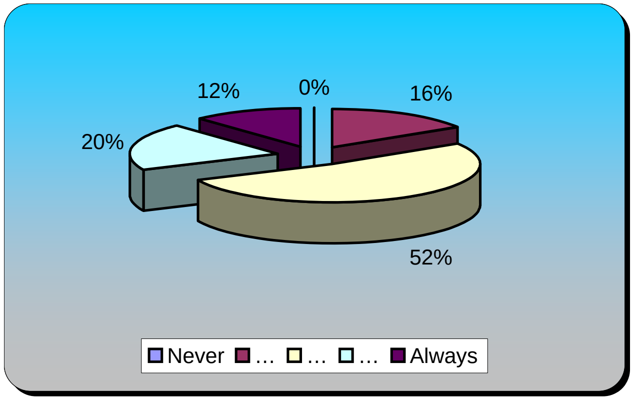
3.) Do you know how to do mass casualty triage?

	Responses	
No	5	22.73%
Yes	17	77.27%
Totals	**22**	**100%**



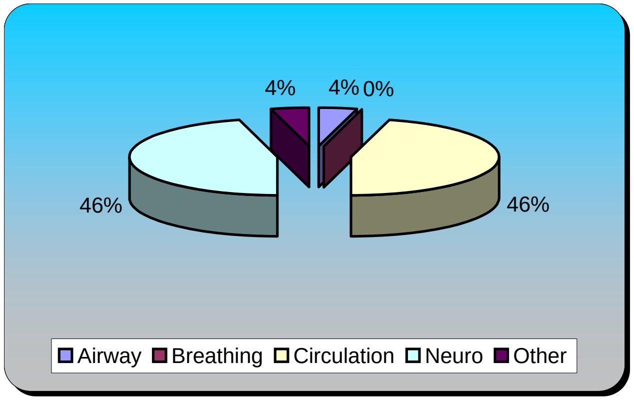
4.) I feel confident doing mass casualty triage.

	Responses	
Never	0	0%
…	4	16%
…	13	52%
…	5	20%
Always	3	12%
Totals	**25**	**100%**



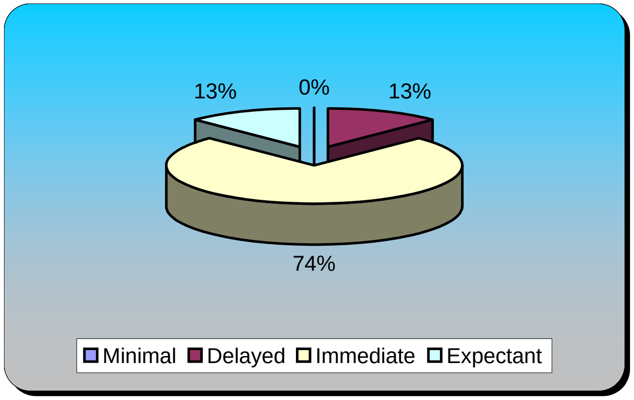
5.) Please make your selection...

	Responses	
Airway	1	4.17%
Breathing	0	0%
Circulation	11	45.83%
Neuro	11	45.83%
Other	1	4.17%
Totals	**24**	**100%**

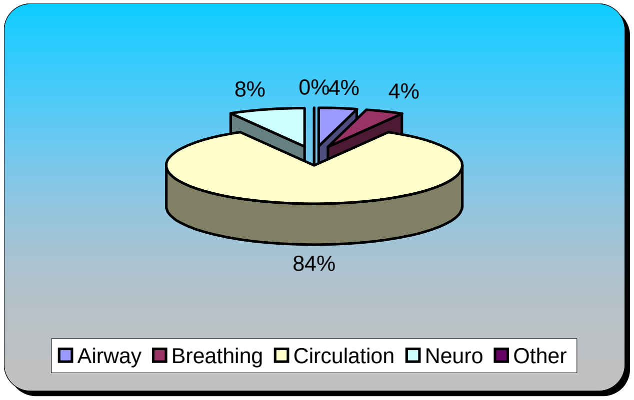


6.) Triage category?

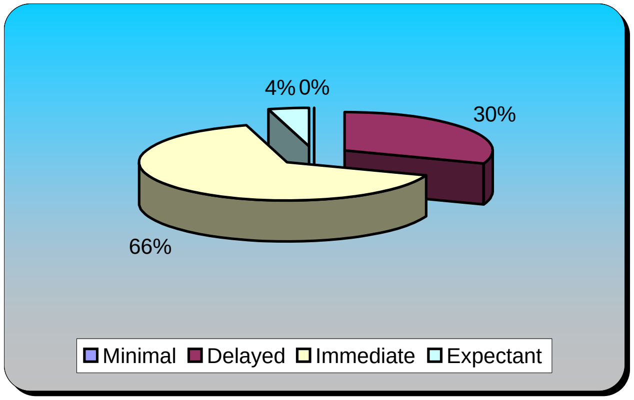
	Responses	
Minimal	0	0%
Delayed	3	12.50%
Immediate	18	75%
Expectant	3	12.50%
Totals	**24**	**100%**



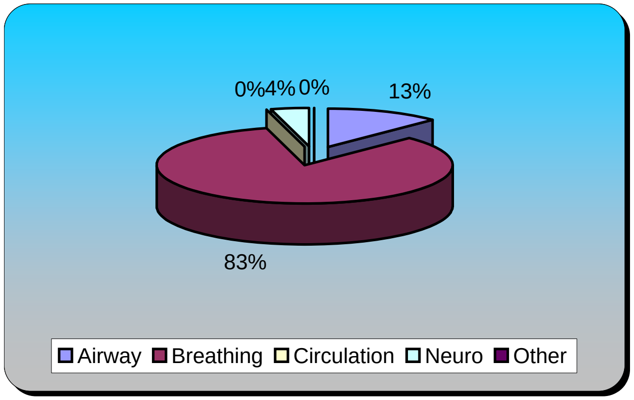
7.) Please make your selection...	Responses	
Airway	1	4.17%
Breathing	1	4.17%
Circulation	20	83.33%
Neuro	2	8.33%
Other	0	0%
Totals	**24**	**100%**



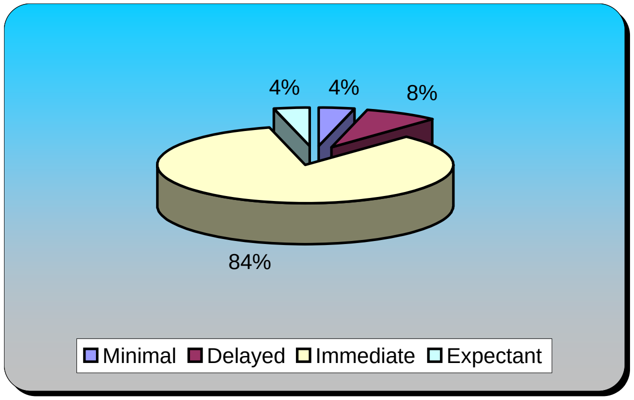
8.) Triage category?	Responses	
Minimal	0	0%
Delayed	7	30.43%
Immediate	15	65.22%
Expectant	1	4.35%
Totals	**23**	**100%**



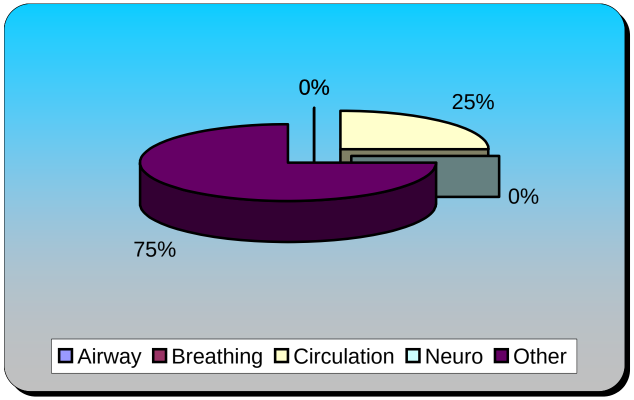
9.) Please make your selection...	Responses	
Airway	3	12.50%
Breathing	20	83.33%
Circulation	0	0%
Neuro	1	4.17%
Other	0	0%
Totals	**24**	**100%**



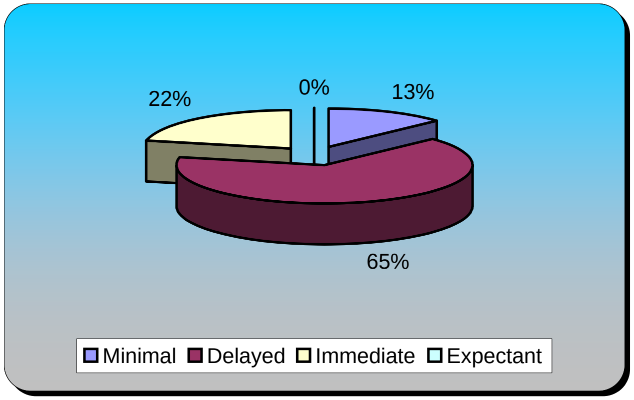
10.) Triage category?	Responses	
Minimal	1	4%
Delayed	2	8%
Immediate	21	84%
Expectant	1	4%
Totals	**25**	**100%**



11.) Please make your selection...	**Responses**	
Airway	0	0%
Breathing	0	0%
Circulation	6	25%
Neuro	0	0%
Other	18	75%
Totals	**24**	**100%**

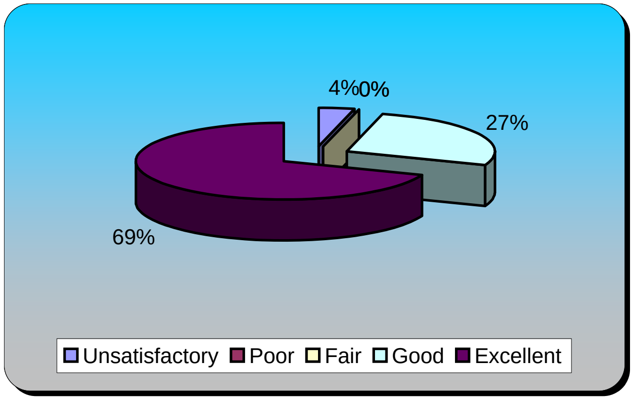


12.) Triage category?	**Responses**	
Minimal	3	13.04%
Delayed	15	65.22%
Immediate	5	21.74%
Expectant	0	0%
Totals	**23**	**100%**



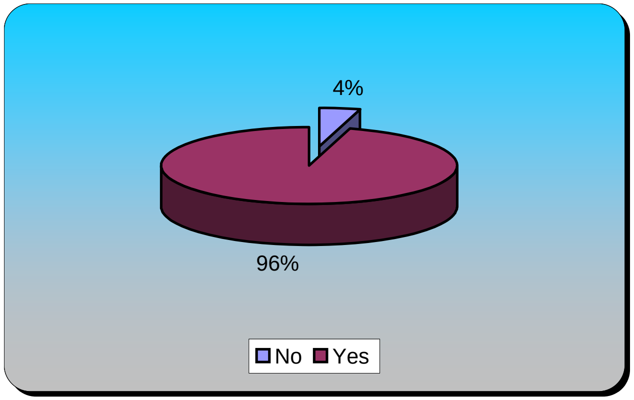
13.) This class was:

	Responses	
Unsatisfactory	1	3.85%
Poor	0	0%
Fair	0	0%
Good	7	26.92%
Excellent	18	69.23%
Totals	**26**	**100%**

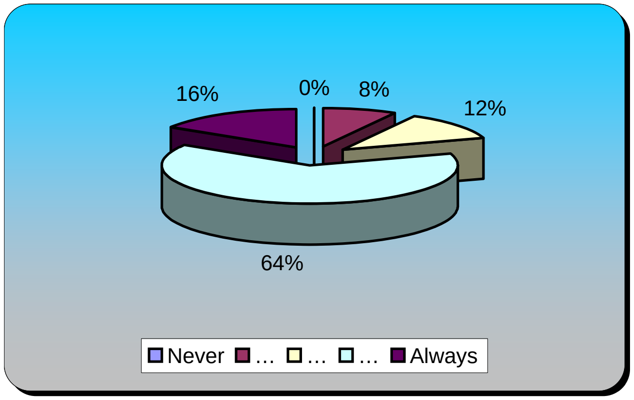


14.) Do you know how to do mass casualty triage?

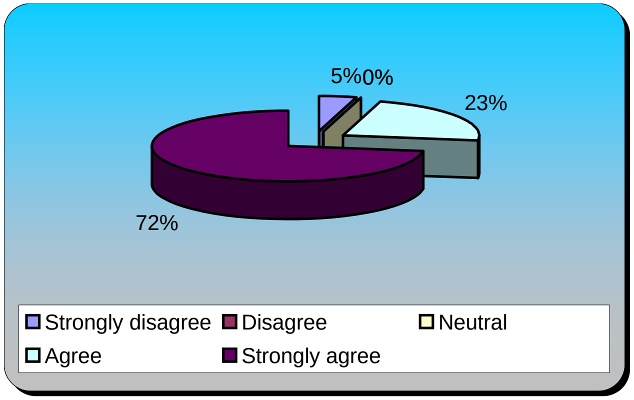
	Responses	
No	1	4.35%
Yes	22	95.65%
Totals	**23**	**100%**



15.) I feel confident doing mass casualty triage.	Responses	
Never	0	0%
…	2	8%
…	3	12%
…	16	64%
Always	4	16%
Totals	**25**	**100%**

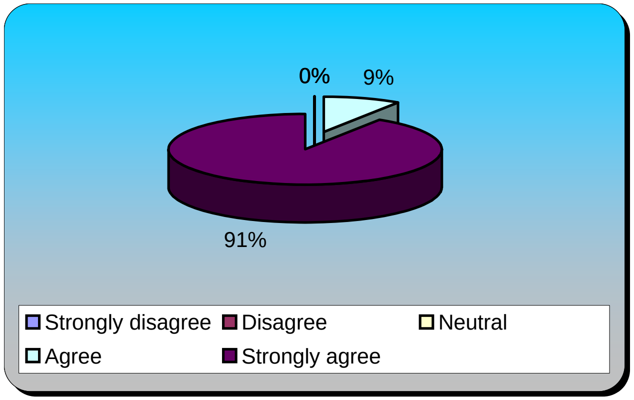


16.) Simulation improved my understanding of mass casualty triage.	Responses	
Strongly disagree	1	4.55%
Disagree	0	0%
Neutral	0	0%
Agree	5	22.73%
Strongly agree	16	72.73%
Totals	**22**	**100%**



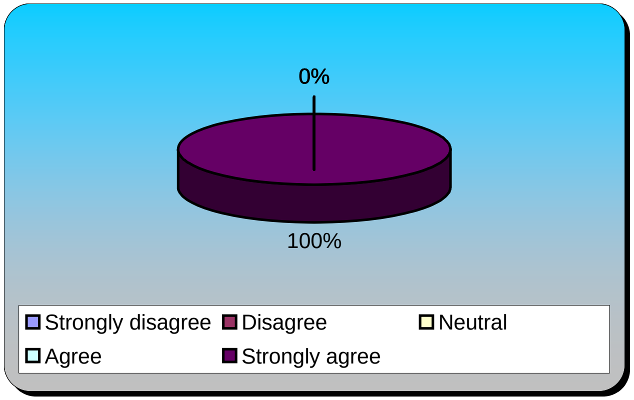
17.) Simulation should be a regular part of mass casualty triage training

	Responses	
Strongly disagree	0	0%
Disagree	0	0%
Neutral	0	0%
Agree	2	9.09%
Strongly agree	20	90.91%
Totals	**22**	**100%**



18.) Learning about mass casualty triage is important for nurses

	Responses	
Strongly disagree	0	0%
Disagree	0	0%
Neutral	0	0%
Agree	0	0%
Strongly agree	24	100%
Totals	**24**	**100%**



Appendix O
Manikin Triage Simulation

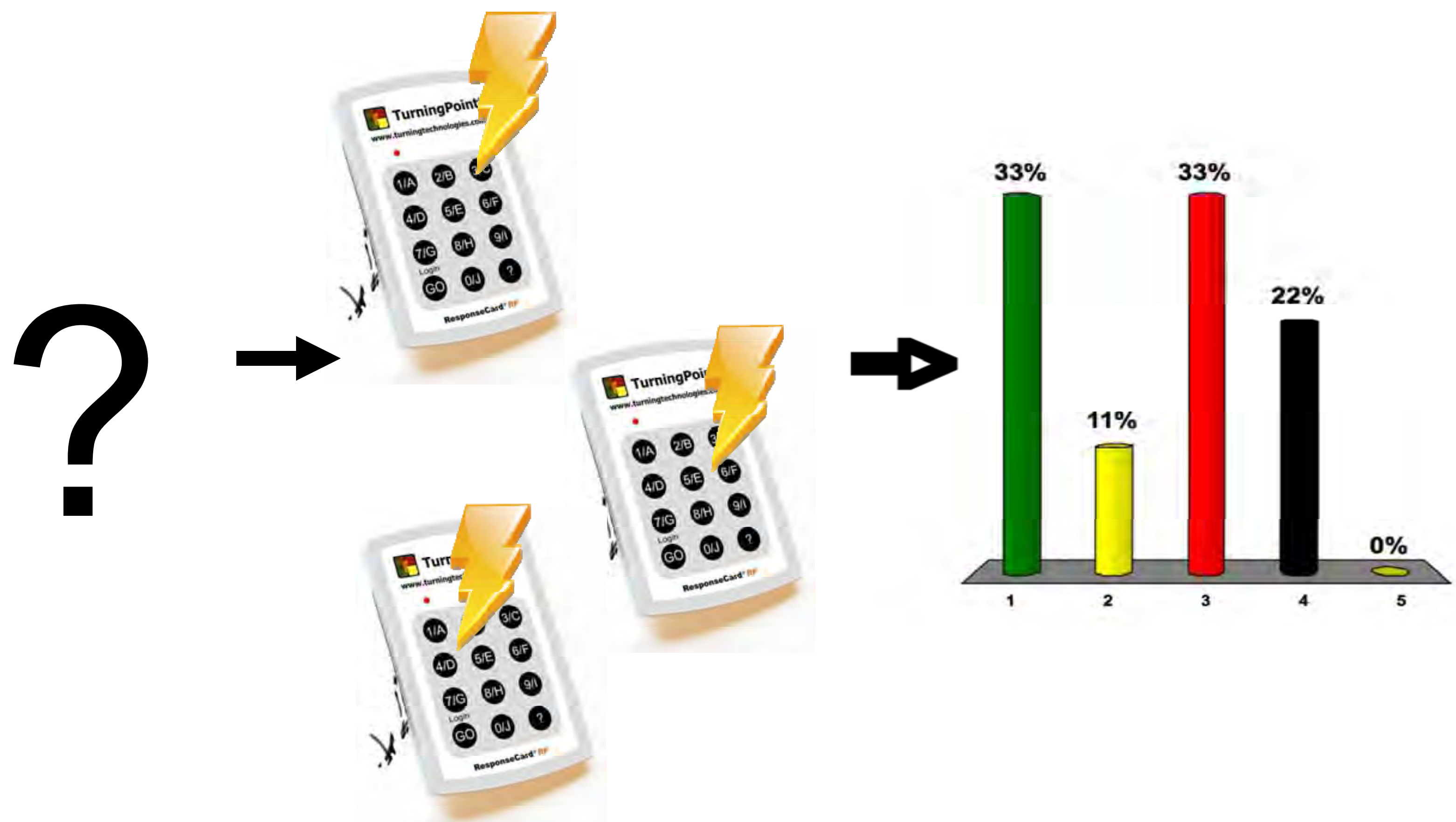
SimTiki

Telehealth Research Institute

Aloha

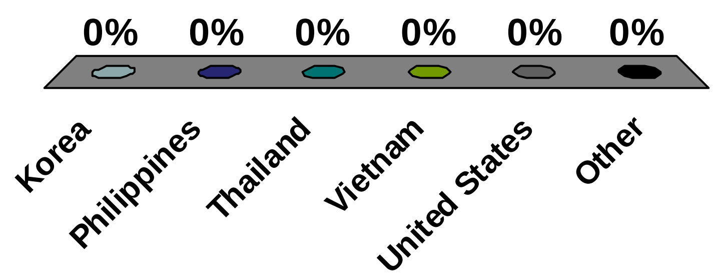
Aloha, Mr.SimMan


www.tu
1/A
3/C
4/D
5/E
6/F
7/G
8/H
9/I
Login
GO
0/J
?
ResponseCard® RF


?
TurningPoint
ResponseCard RF
33%
11%
33%
22%
0%
1
2
3
4
5

My country is

1.  Korea
2.  Philippines
3.  Thailand
4.  Vietnam
5.  United States
6. Other



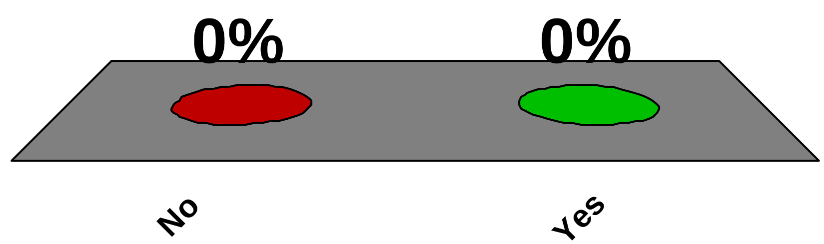
0 of 60

Have you used Mr.SimMan before?

(or someone like SimMan)

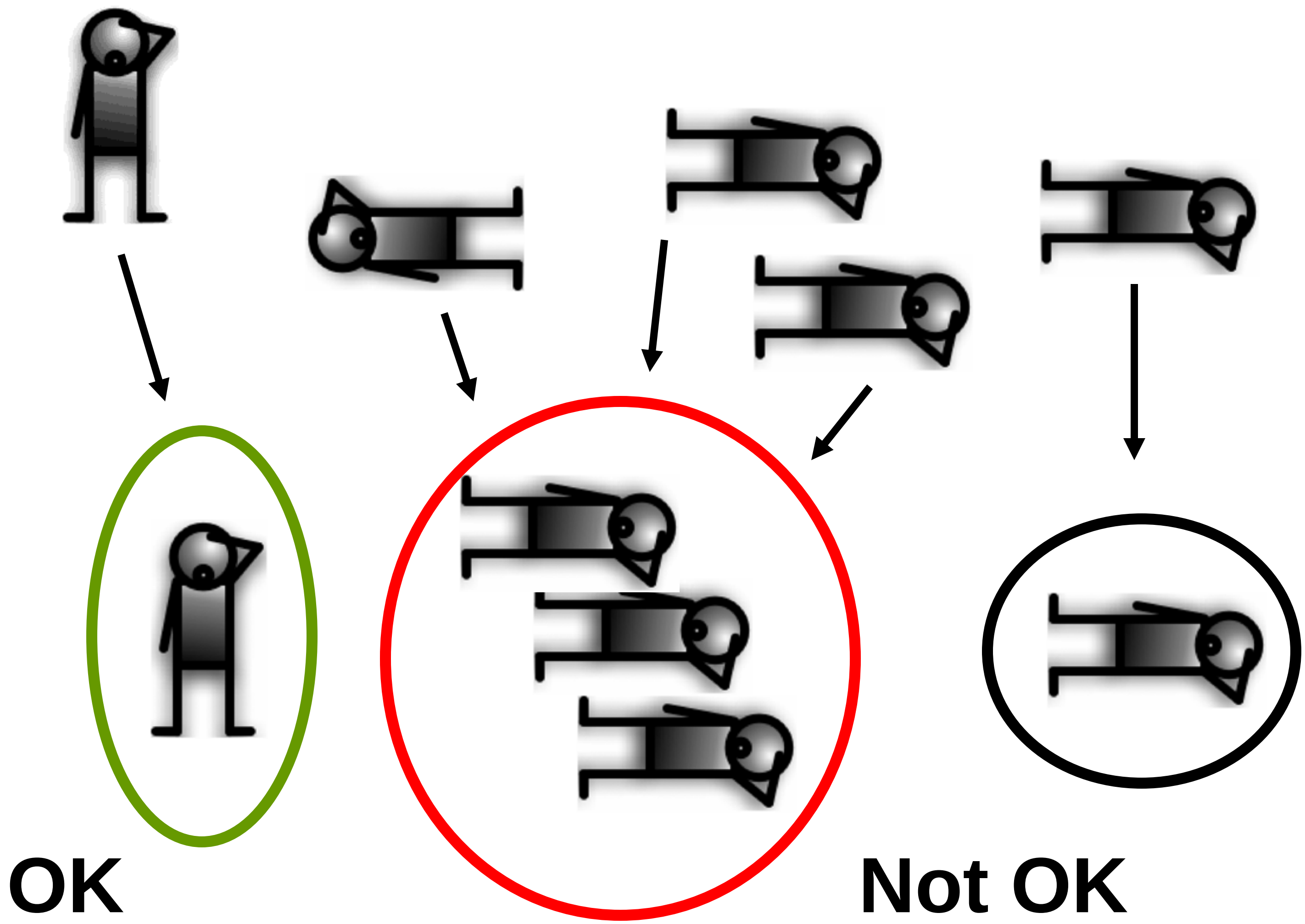
1. No
2. Yes

0 of 60




TRIAGE
Triage

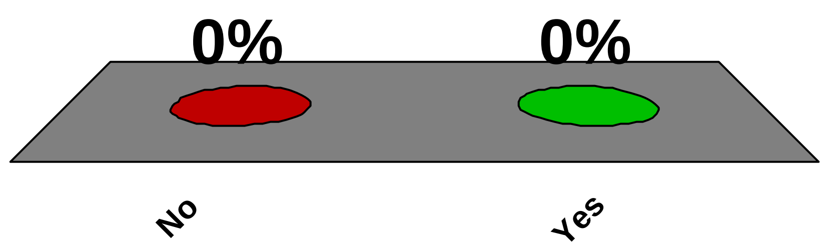
Triage = Sort



Do you know how to do mass casualty triage?

1. No
2. Yes

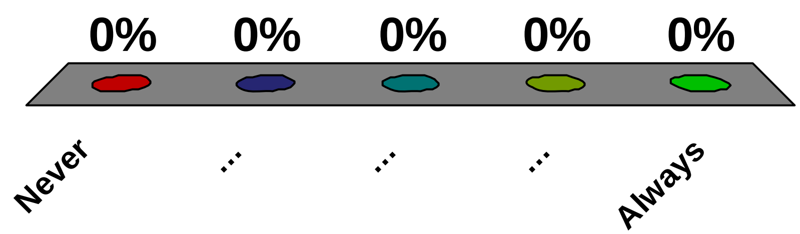
0 of 60



I feel confident doing mass casualty triage.

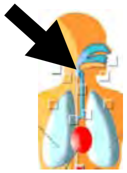
1. Never 
2. …
3. …
4. …
5. Always 

0 of 60

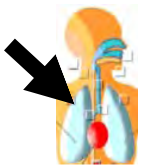


Examine

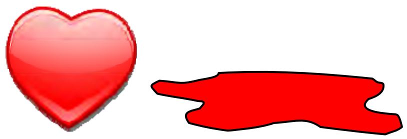
Airway



Breathing

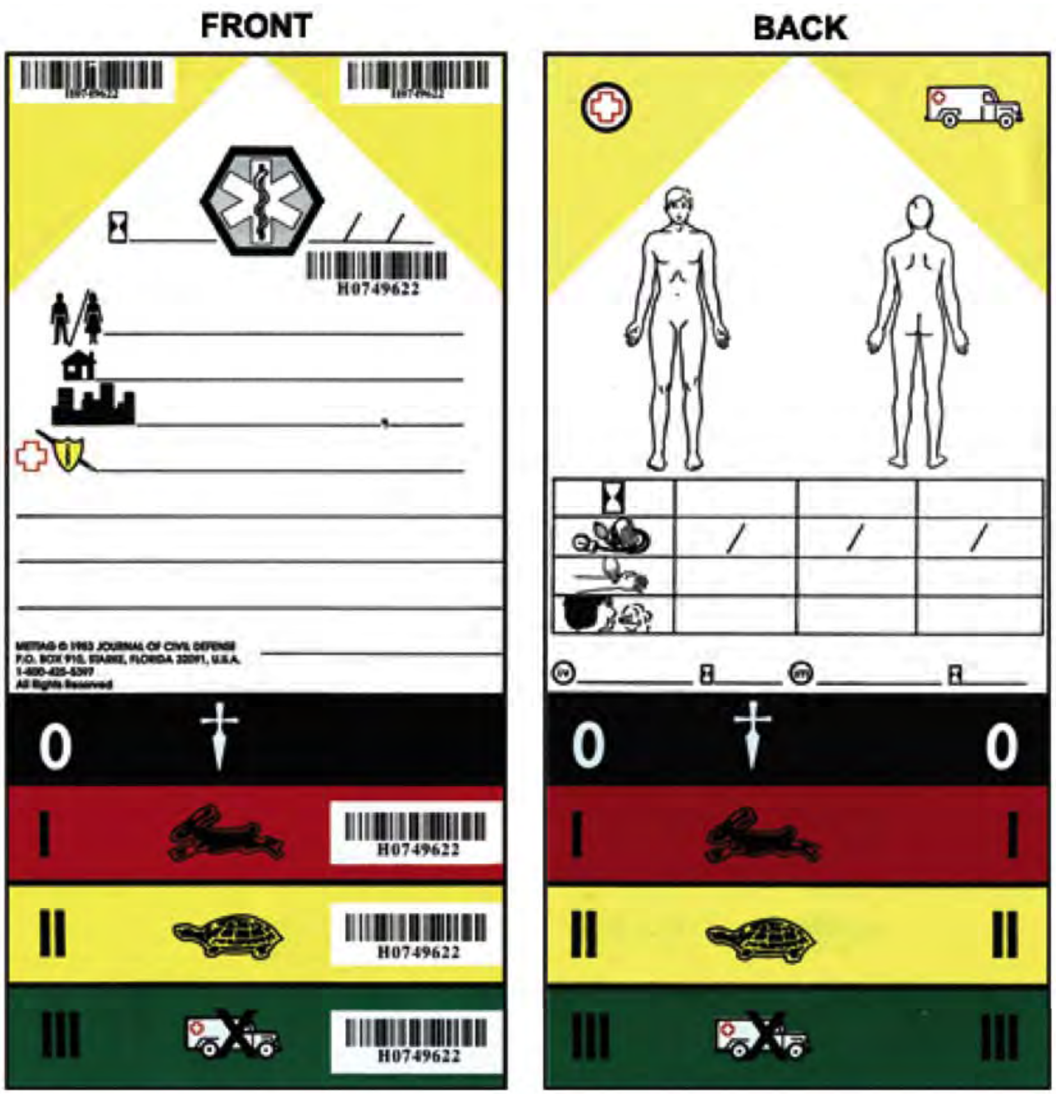


Circulation

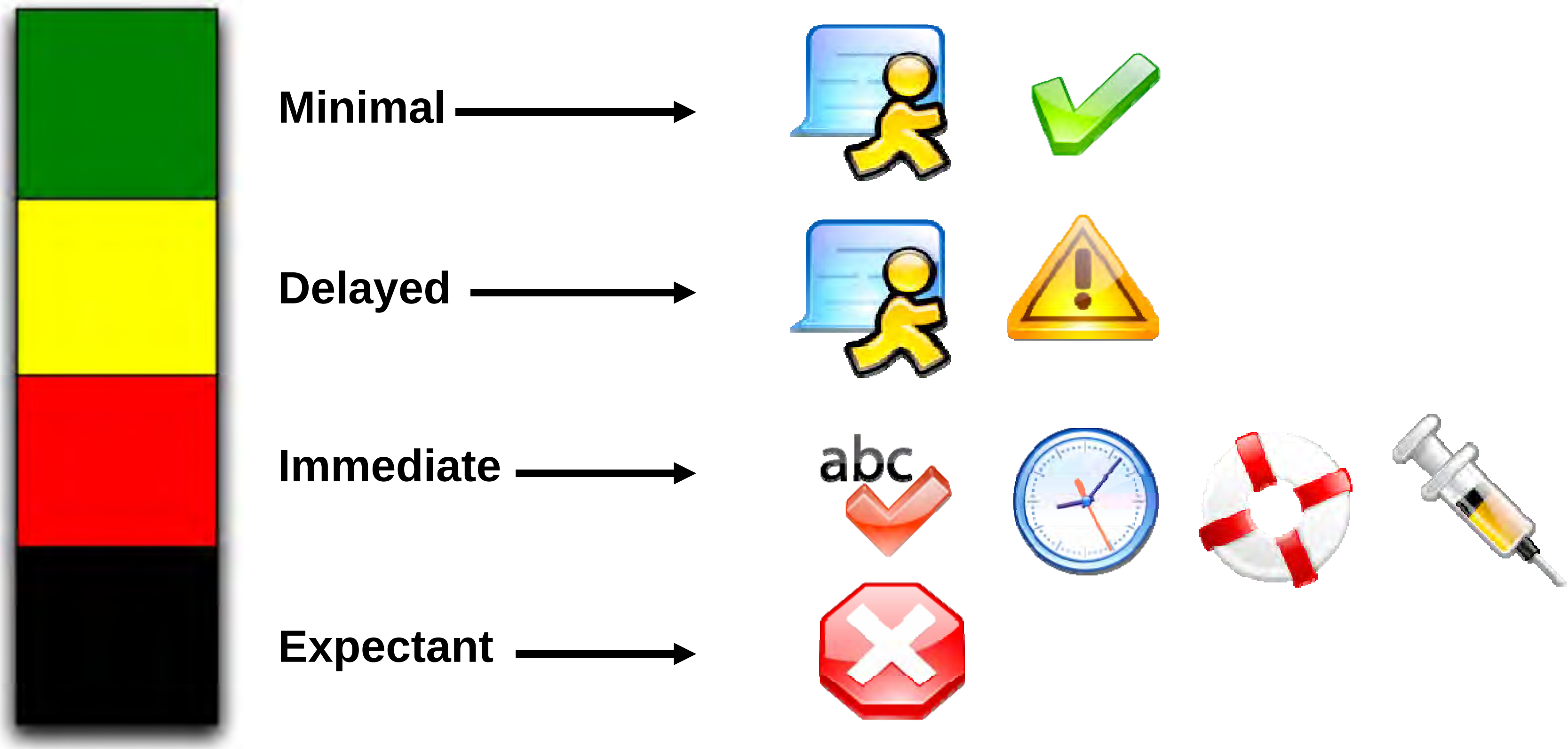


Neurological

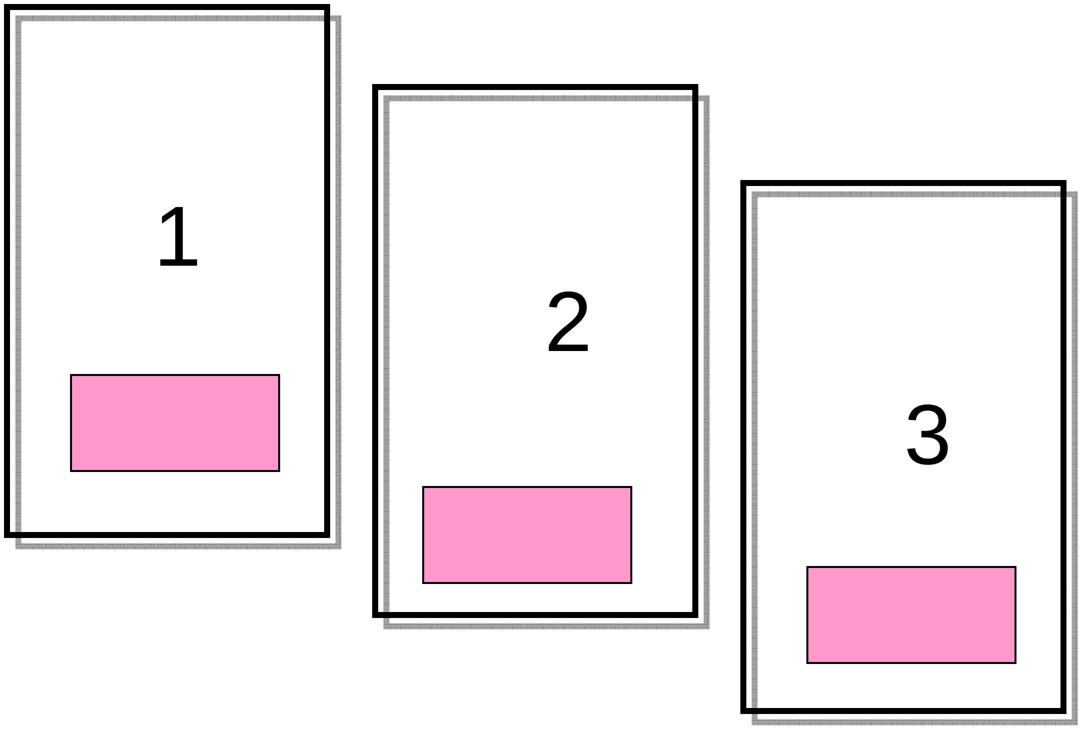
Tag



Tag



Equipment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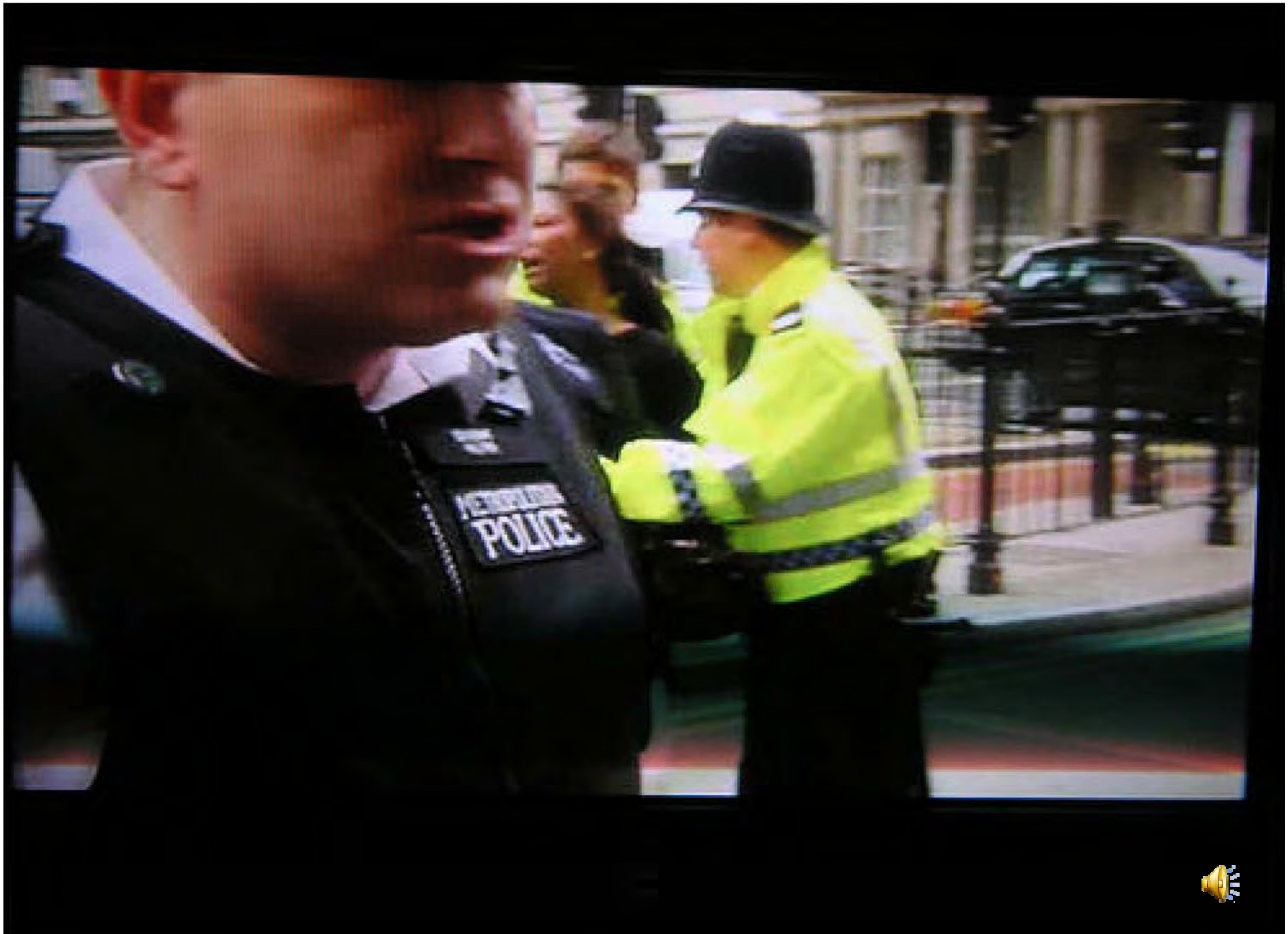
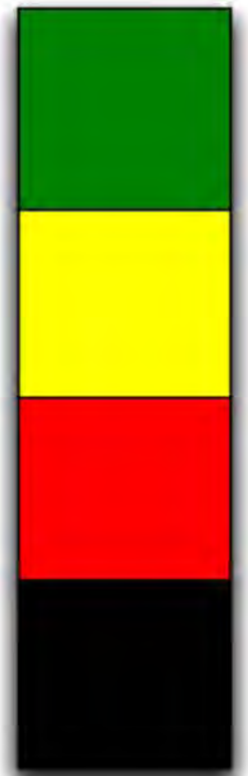
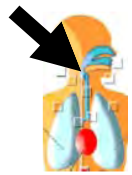
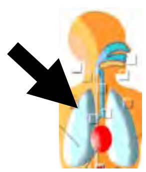
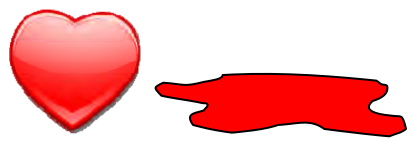

POLICE

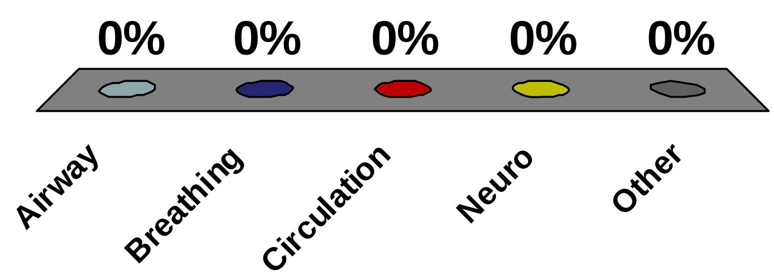
Examine the patient.

You have 90 seconds . . .



?

1. Airway 
2. Breathing 
3. Circulation 
4. Neuro 
5. Other



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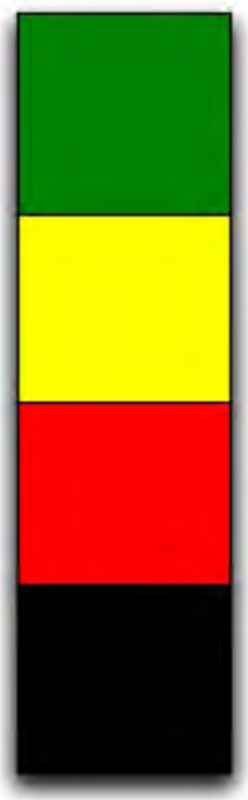
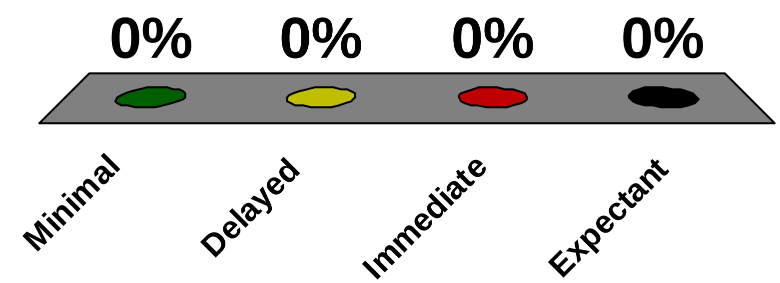
Triage category?



1. Minimal
2. Delayed
3. Immediate
4. Expectant



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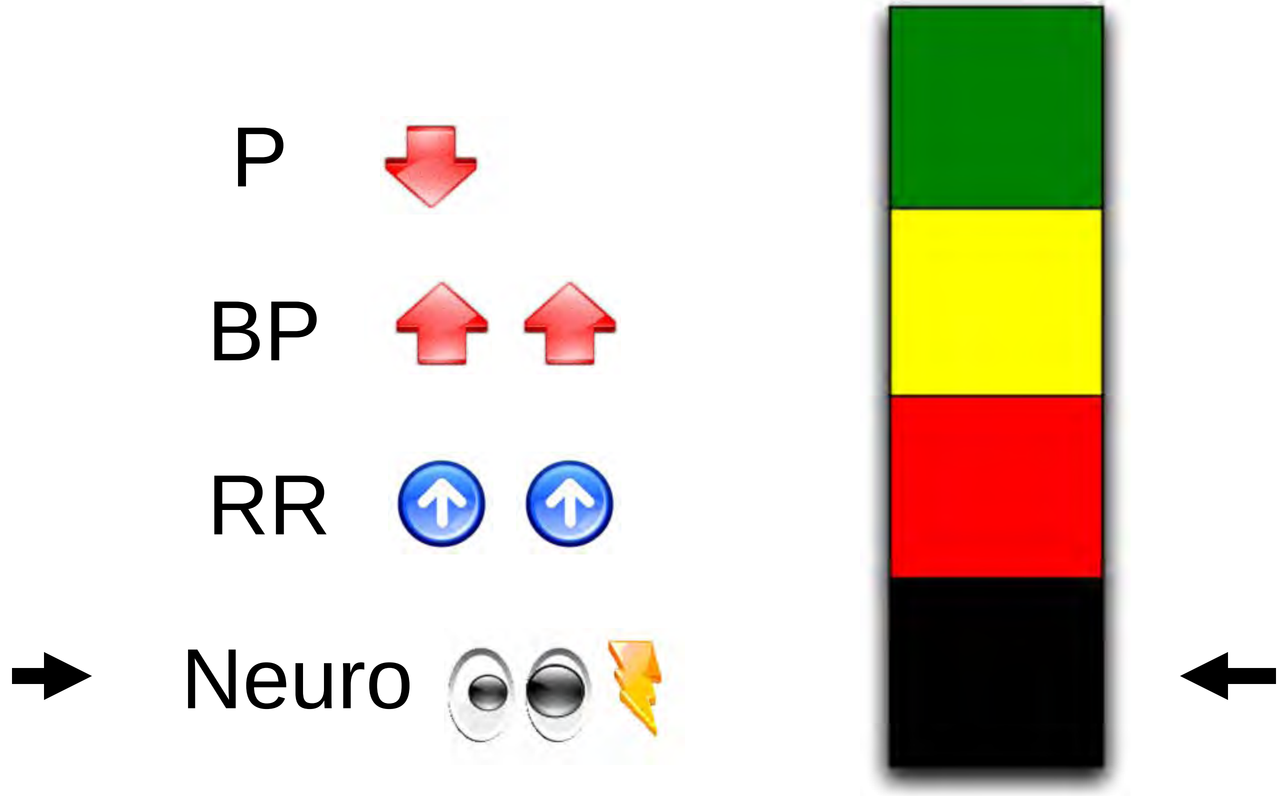
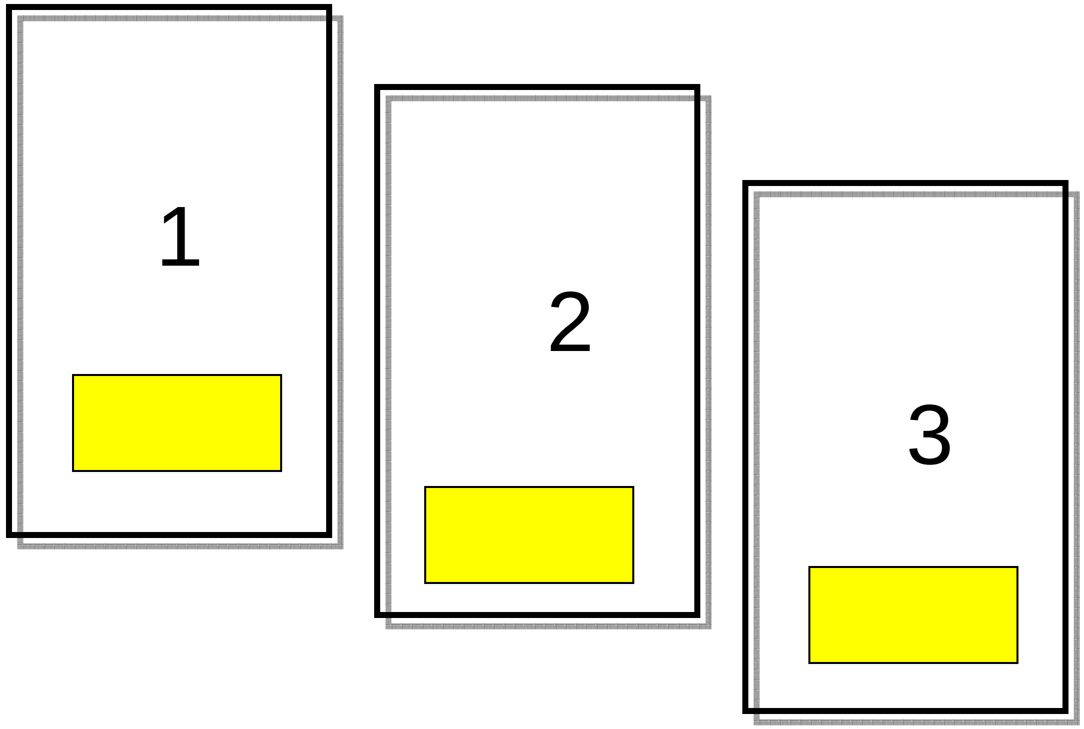
Traumatic Brain Injury




1
2
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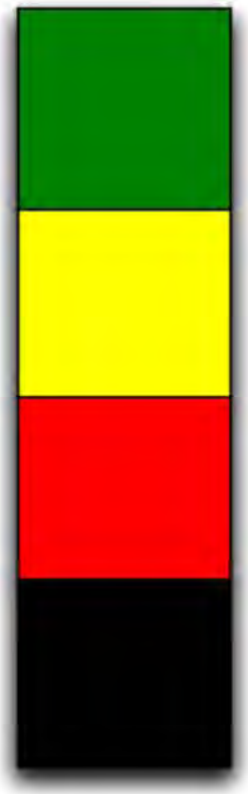
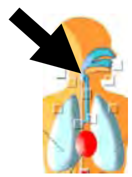
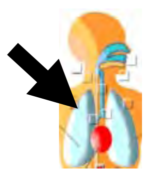
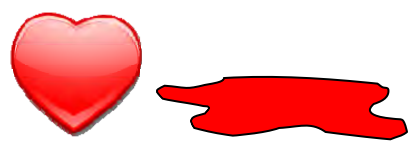
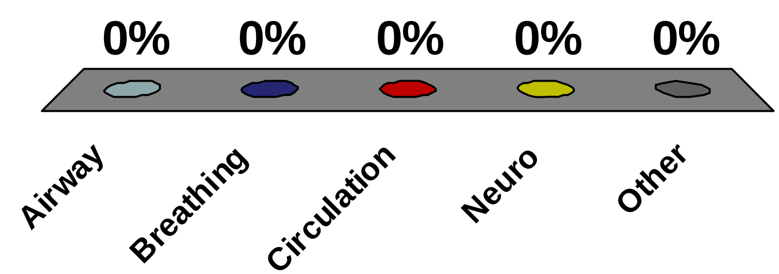
Examine the patient.

You have 90 seconds . . .



?

1. Airway 
2. Breathing 
3. Circulation 
4. Neuro 
5. Other



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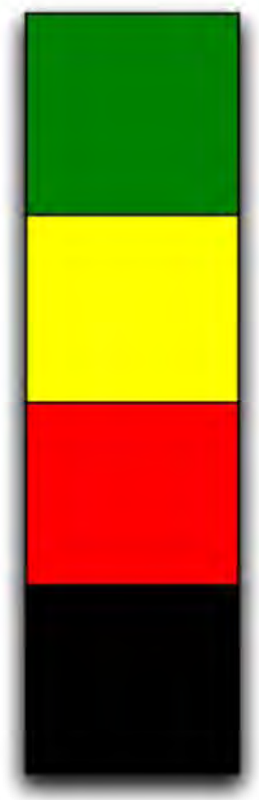
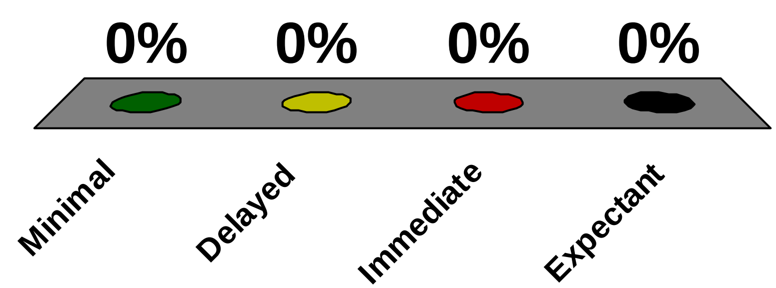
Triage category?



1. Minimal
2. Delayed
3. Immediate
4. Expectant



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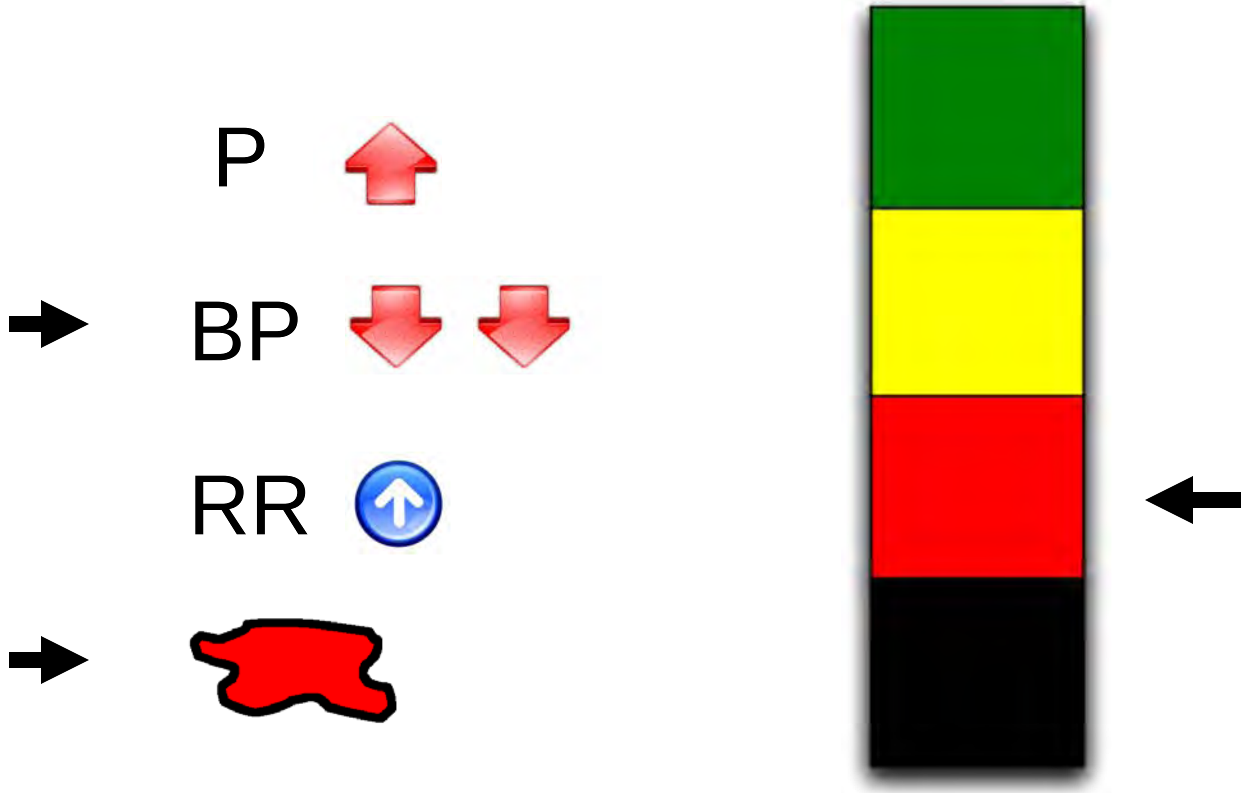
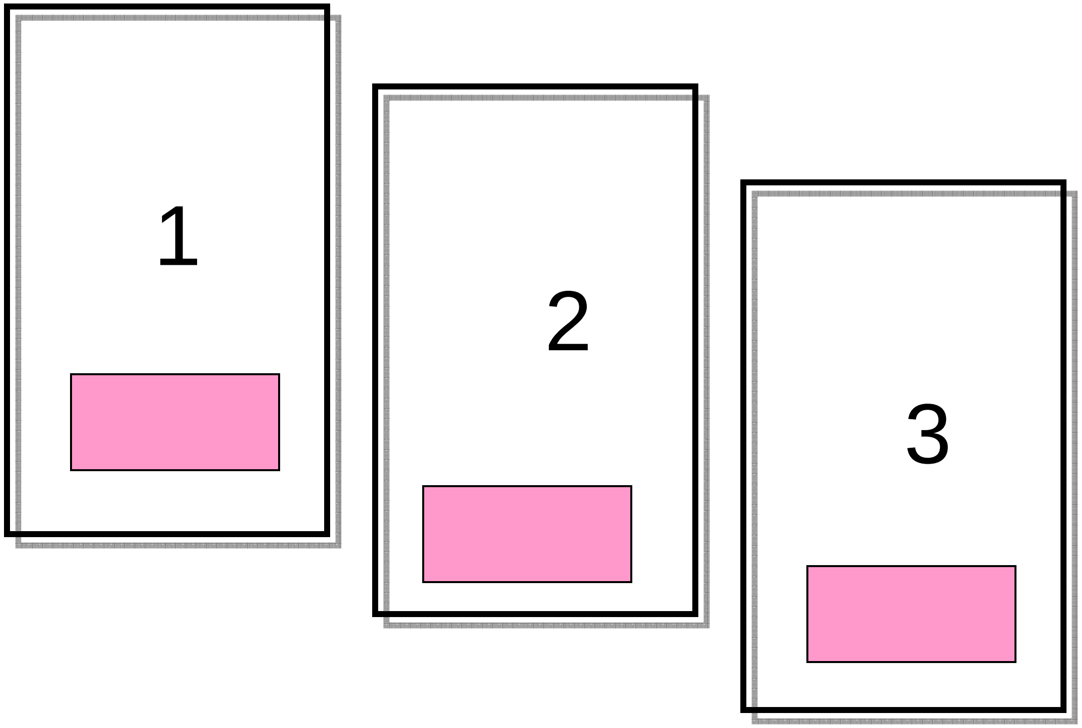
Hemorrhagic Shock

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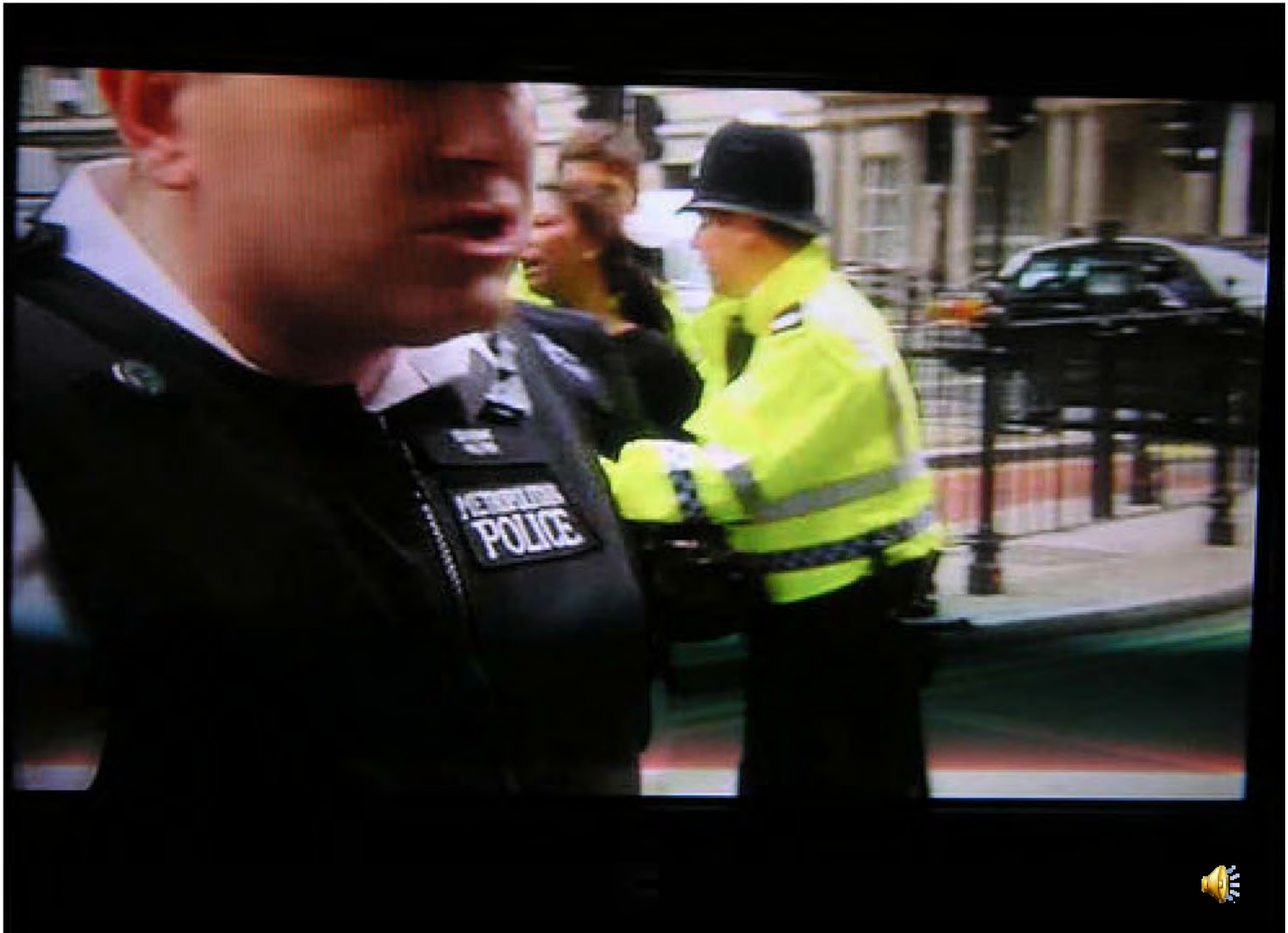
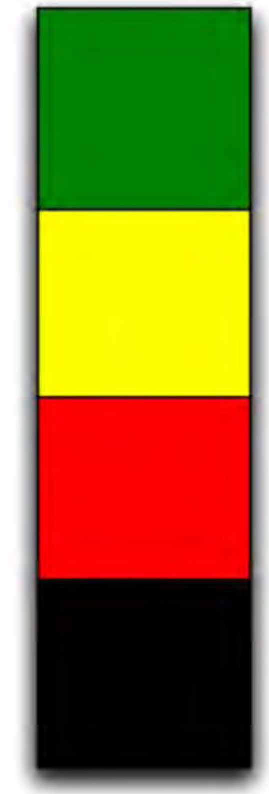
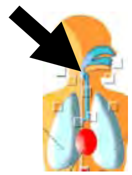
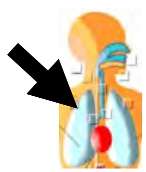
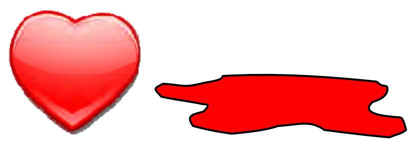

POLICE

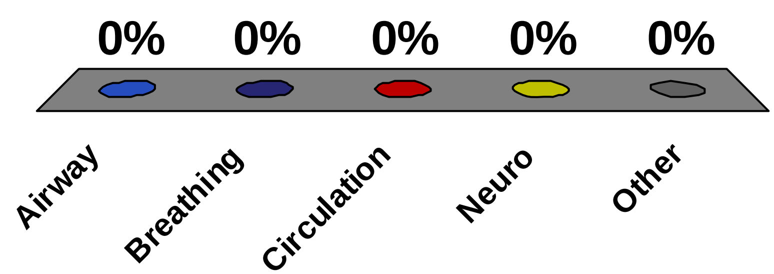
Examine the patient.

You have 90 seconds . . .



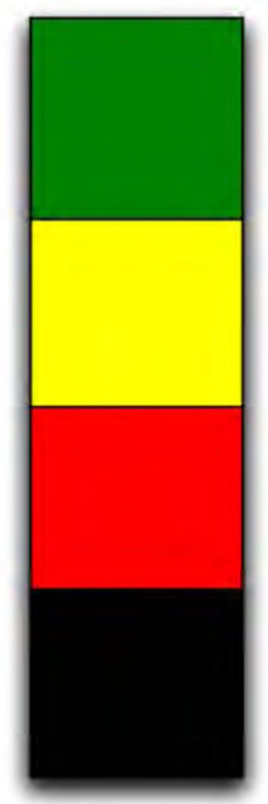
?

1. Airway 
2. Breathing 
3. Circulation 
4. Neuro 
5. Other

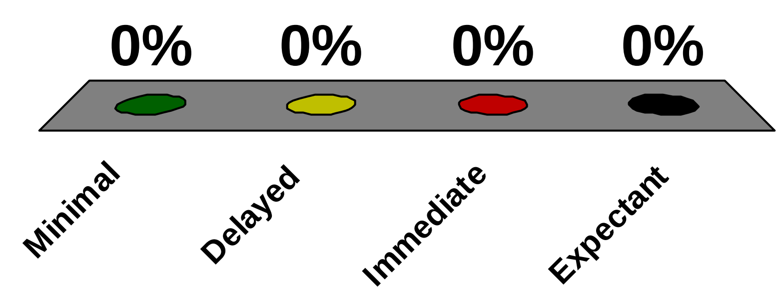


0 of 60

Triage category?



1. Minimal
2. Delayed
3. Immediate
4. Expectant



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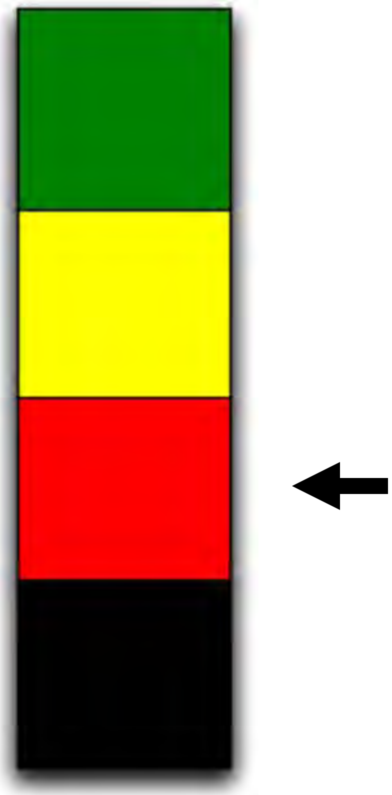
Tension Pneumothorax

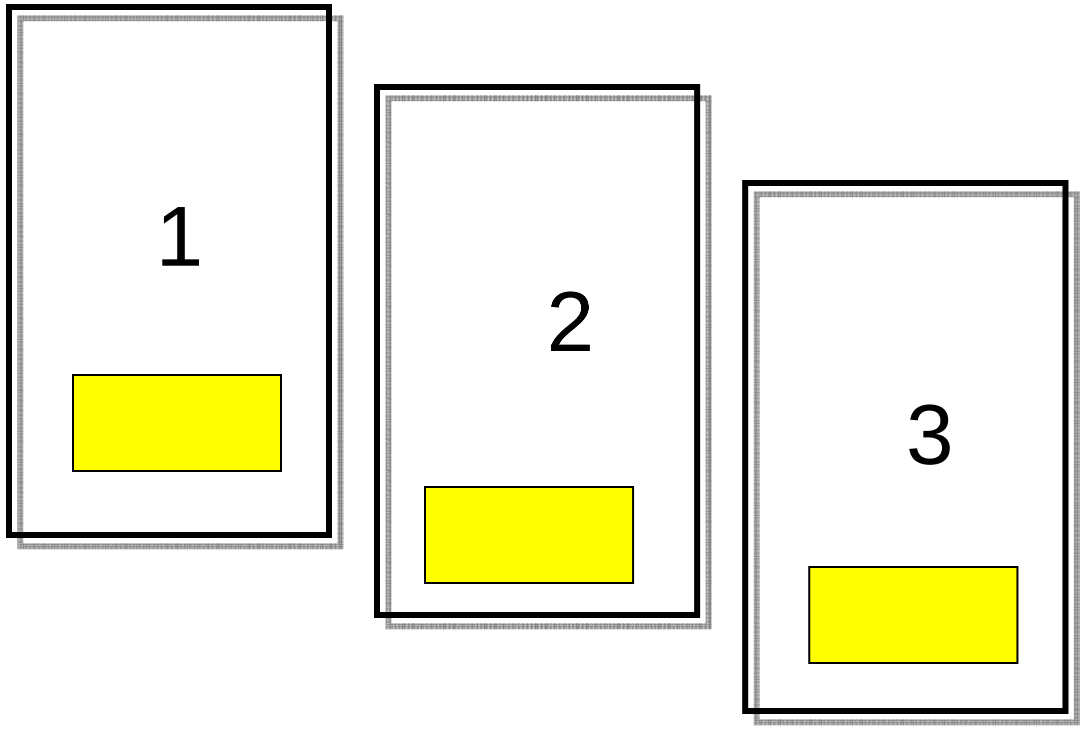
P 

BP 

RR 

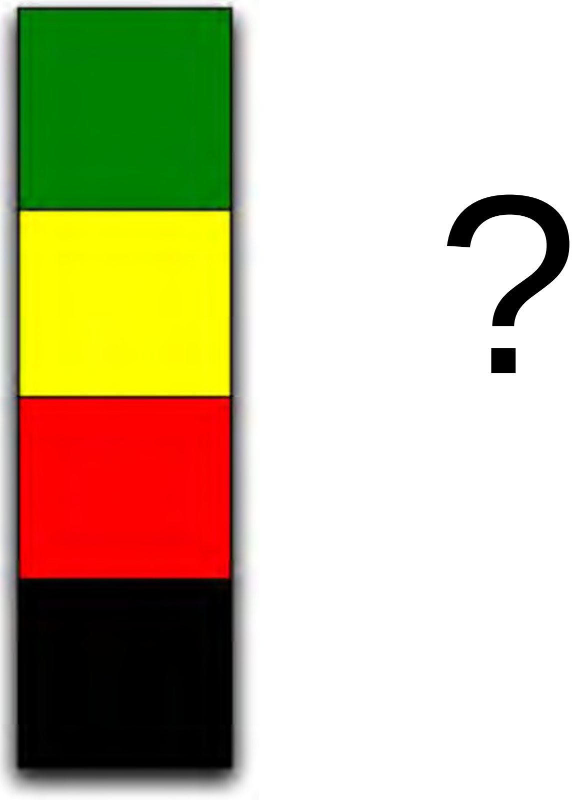
"I can't breathe" 

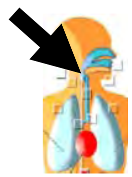


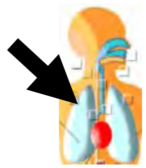

1
2
3

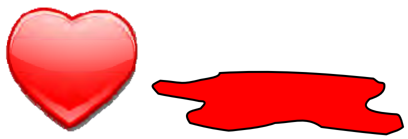
Examine the patient.

You have 90 seconds . . .



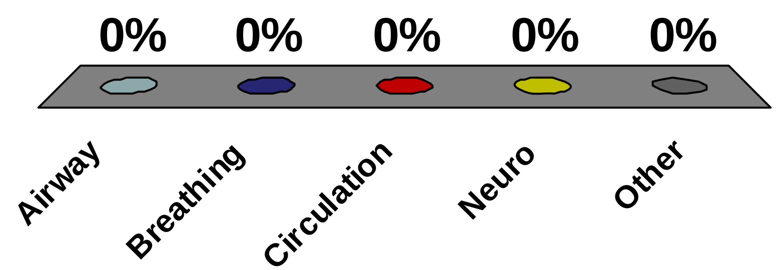
1. Airway 

2. Breathing 

3. Circulation 

4. Neuro 

5. Other



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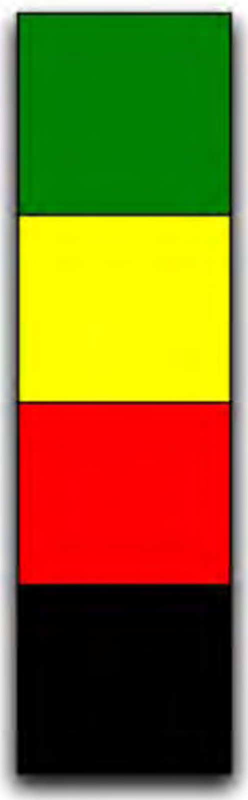
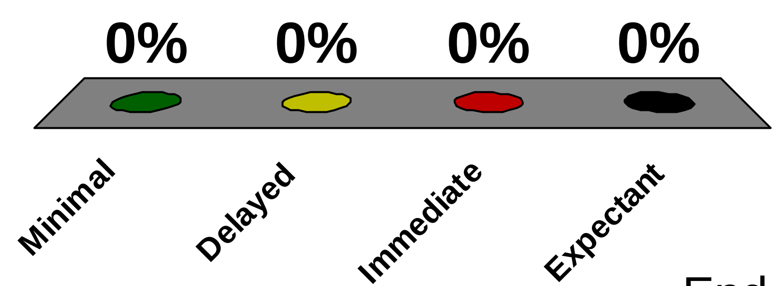
Triage category?



1. Minimal
2. Delayed
3. Immediate
4. Expectant



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End

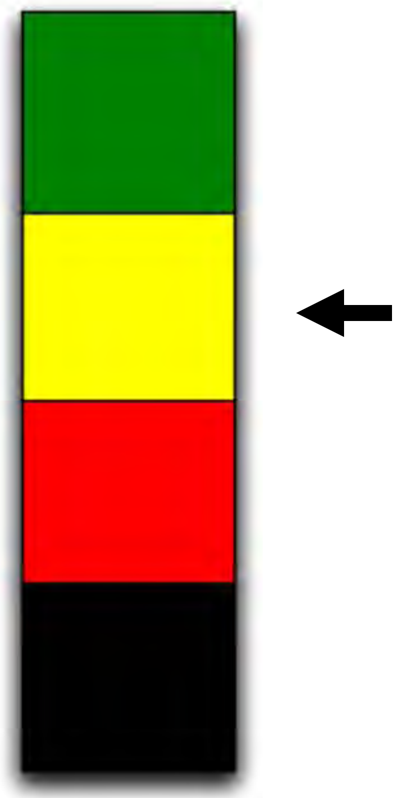
Leg Fracture

P

BP

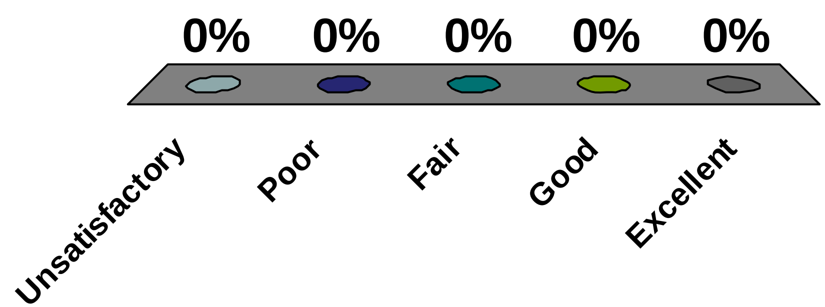
RR

“My leg is broken”



This class was:

1.  Unsatisfactory
2.  Poor
3.  Fair
4.  Good
5.  Excellent



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Do you know how to do mass casualty triage?

1. No
2. Yes

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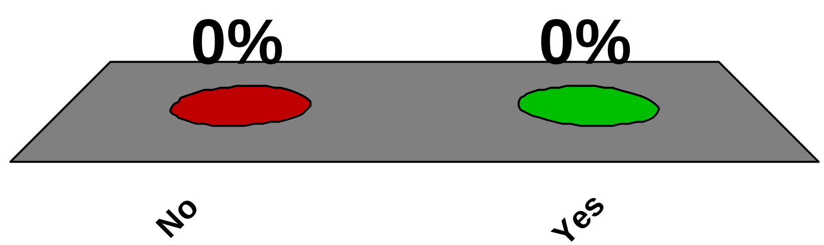

I feel confident doing mass casualty triage.

1. Never
2. …
3. …
4. …
5. Always

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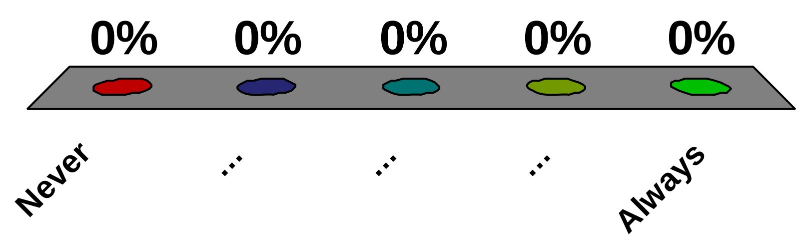
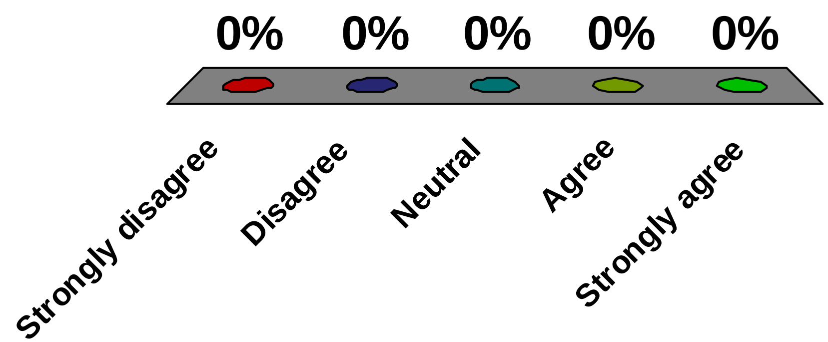


Simulation improved my understanding of mass casualty triage.

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree



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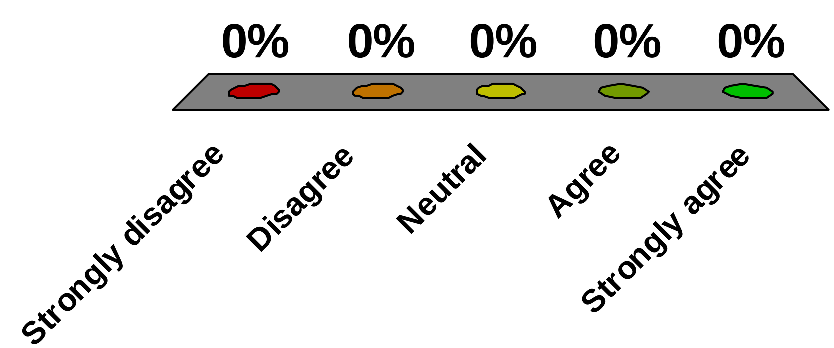
Simulation should be a regular part of mass casualty triage training

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree



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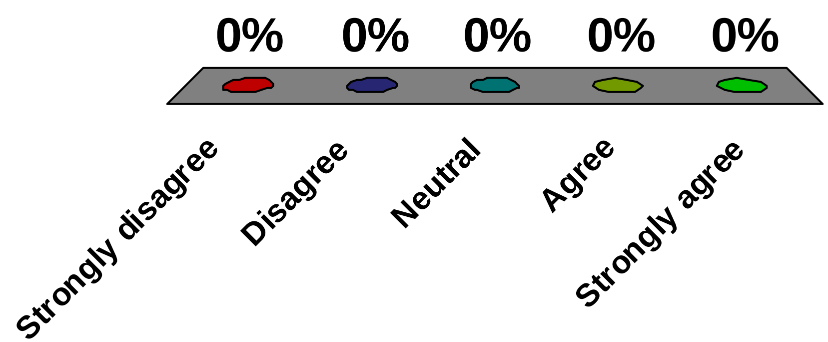
Learning about mass casualty triage is important for healthcare workers

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree



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9/I
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ResponseCard

Thank You

SimTiki

Telehealth Research Institute