Technology Innovations to be Presented at the 13th Annual International Meeting on Simulation in Healthcare

January 26th–30th, 2013
Orlando, Florida

1st Place – 1395

An iPad Simulation of Skin Prepping

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2nd Place – 975

An In Situ Tele-mentoring System for Training Endoscopic Surgery in the Operating Room

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3rd Place – 461

Development of Computer-based Simulation and Gaming for Teaching Emergency Medicine in Tanzania: A Resource Limited Environment

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3rd Place – 1363

Testing a Hand Hygiene Compliance Monitoring System Utilizing a Depth-Sensing Camera in a Simulated Clinical Environment

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39

Showing Signs of Life Using Medium-fidelity Manikins

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Introduction/Background: A huge expense when starting the integration of simulation into a nursing program is the manikins, computers, and audio/visual equipment. Often the choice between purchasing one high-fidelity manikin and several medium-fidelity manikins centers on the functionality that might be lost if only medium-fidelity manikins are purchased. One of these is the inability to display vital signs with the medium fidelity manikins since the software platform does not directly tie to a patient monitor. The lab staff at the St. David's School of Nursing at Texas State University wanted to see if it would possible to overcome this limitation by utilizing existing in-house hardware and software resources, via purchase of additional budget-friendly technology supplements, or through a combination of both.

Description: The first step in the process was to identify which existing resources could be repurposed to possibly add the desired vital sign functionality. At Texas State, the simulation labs were already equipped with touchscreen monitors at each bedside in order to facilitate the use of a SimMan® at any location. Although this was ideal in terms of flexibility for where high-fidelity simulations could be performed, these monitors were sitting idle whenever a VitalSim™ manikin occupied the same space. Also, the labs were connected with several Laerdal AVS servers which, in addition to capturing raw video feeds and manikin event logs, can be used to separately record the patient monitor display output from the SimMan® software program. The missing link in combing these two elements was the lack of spare technology resources in the labs. To overcome this limitation, several new "netbooks" were purchased so that each bedside would have its own computer. The netbooks were chosen for several reasons: (1) the minimal footprint needed for implementation, (2) the relatively small cost to obtain, and (3) their ability to be used for separate lab applications besides the vital signs project. Once the new computers were purchased, separate headwall shelves were also ordered to mount the netbooks and the VitalSim™ control units on. The shelf purchase allowed the new vital sign functionality to be incorporated without sacrificing existing lab workspace. Once all the necessary technology resources were in place, the lab staff utilized the patient monitor recording feature of the AVS client software to produce the desired output that was requested by the nursing faculty. Since the recorded files are saved in an .AVI format (by default) they can be viewed natively on any pc with Windows Media Player installed. The only option that needed to be changed was in setting the WMP program to loop the video continuously so that it would not time out. The resulting video files were copied to the netbooks to be used during scenarios and instructors were provided with training on how to use them.

Conclusion: The end result was a significant increase in the realism that could be provided during scenarios. Visual representation of patient vitals helped to add key information for patient care decisions that students could not obtain from assessment procedures alone. Instructors were able to augment their VitalSim™ scenario planning by incorporating parameters that were previously unavailable to them (such as patient temperature, heart rhythms, and oxygen saturation). Most importantly, these system enhancements were able to be performed in a very cost-effective manner in relation to trying to upgrade the manikins themselves.

Disclosures: Tiffany Holmes, DC was a Laerdal Medical-Contract Educational Specialist (no longer in this position).

217

The Incredible Embeddable Egg: An Inexpensive Model for Simulating Corneal Foreign Bodies and Teaching Slit Lamp-associated Skills

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Introduction/Background: Patients commonly present to the ED with embedded corneal foreign bodies (FBs). With rare exception, emergency physicians are the only non-ophthalmologists who treat these patients. Current treatment recommendations include prompt removal. The Model of Clinical Practice of EM identifies "FBs of the eye" and techniques necessary for their management (e.g. slit lamp examination, FB/rust ring removal) as knowledge essential for the independent practice of EM. In the past our faculty have taught residents how to manage corneal FBs by supervising direct patient care, giving didactic lectures, and moderating small-group procedure workshops. None of these methods provided opportunities for guided practice. Several investigators have described teaching ophthalmology-related content to residents, providing opportunities for guided practice, using organic (e.g. bovine, rabbit) or inorganic (Styrofoam/fiberglass human-sized head with paraffin-coated glass spheres) models. Guided by Pilura's description of the cornea as "having the consistency of a hard-boiled egg with the shell removed," we introduced chicken eggs (hard-boiled, with shell and membranes removed, rolled in salt/pepper, and anchored to the slit lamp) as a novel, cost-effective alternative for teaching basic slit lamp operation and embedded corneal FB removal techniques.

Description: Construction of the model starts with preparation of two hard-boiled eggs. Following shell and membrane removal, the end portion of each egg is dipped in salt/pepper to embed several foreign bodies into the surface. The completed eggs are then secured to the chin rest of a conventional slit lamp using tape and a plastic or foam container so that the learner can visualize the egg surfaces and the embedded foreign bodies through the magnifying lenses of the slit lamp. Learners then engage in several tasks related to basic slit lamp operation: turning on the light source, selecting the appropriate light, aligning the light source so that it adequately enhances visualization of the embedded foreign bodies, and focusing the magnifying lenses for

MODEL SET-UP

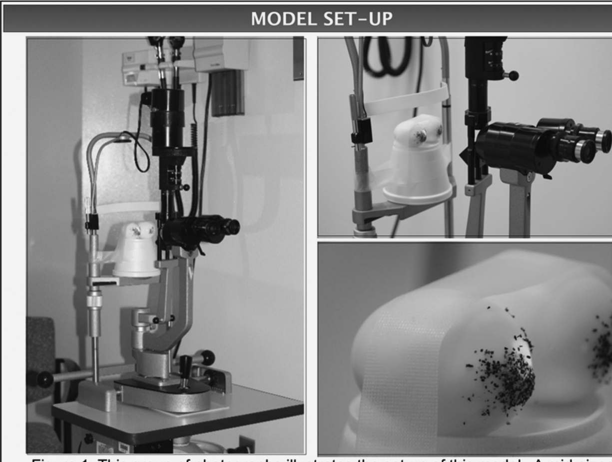

Figure 1. This group of photographs illustrates the set-up of this model. A mid-sized Styrofoam cup sits atop the chin rest. Two hard-boiled eggs coated in pepper are taped to the cup.

MODEL IMPLEMENTATION

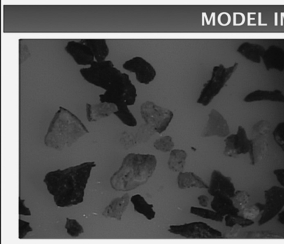

Figure 2. This photograph illustrates the view of the egg covered in pepper through the slit lamp.

Figure 3. A small gauge needle is used to remove a FB from the egg's surface.

The authors have no financial relationships or affiliations to disclose.

optimal viewing. Following their performance of these tasks, learners engage in several facilitated attempts at simulated corneal foreign body removal using a small gauge needle, jeweler's forceps, or a similar foreign body removal instrument. Learners deliberately practice corneal foreign body removal using both their dominant and non-dominant hands under the observation and guidance of facilitators.

Conclusion: Following our sessions with this model, 84.2% of evaluating residents stated that they strongly agreed that sessions taught using this model "met conference objectives" and "helped teach me new/helped refresh my existing knowledge." Although the possibility of precipitating anaphylaxis or transmitting food-borne illnesses (while remote) exists with use of this model, we believe that it represents an andragogy suitable for teaching basic slit lamp-associated skills, simulating embedded corneal foreign bodies, and providing learners with opportunities for deliberate, facilitated practice in corneal foreign body removal.

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Disclosures: None

239

Innovative Engineering of a Mid-fidelity Simulation Model for Cerebrospinal Fluid Drainage

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Introduction/Background: Drainage of cerebrospinal fluid (CSF) using devices such as a ventriculostomy or lumbar drain can be life saving but also places a patient at risk for potentially life-threatening complications such as brain herniation and infection. The insertion and management of these devices require high-level psychomotor skills and errors can be catastrophic for the patient. Procedures such as ventriculostomy insertion, continuous or intermittent drainage of CSF, CSF sampling for laboratory analysis and dressing changes are currently taught to nurses and physicians during real-time patient care situations due to the lack of an appropriate simulation model, putting the patient at risk during the learning process. Patients with these devices may be cared for in units where the procedures are common and therefore simulation instruction may be useful for initial training. However, patients with ventriculostomies are also managed in units where these procedures are high-risk, low frequency (cardiothoracic intensive care for aortic abdominal aneurysm repair, general medical/surgical ICUs or orthopedic spine services). In this instance, initial and ongoing training using simulation would be of benefit in establishing and maintaining this complex skill set.

Description: A mid-fidelity simulator was engineered to target all clinicians involved with the insertion and maintenance care of CSF drainage devices. The Simulaids ALS Trainer manikin® was modified to accept an intraventricular catheter in the head and a lumbar catheter in the back. A small incision was made to the manikin at the posterior midline of the neck starting at the base and ending just prior to the occiput. Next the jaw was removed making it possible to access the cranial cavity. A power drill was used to make a hole in the skull of the manikin and an extraventricular drainage catheter was placed using the typical anatomical landmarks (Kocher's point) and tunneling technique under the scalp. The catheter manufacturer's leur connecter was inserted in the catheter tip exiting the head for connection to an external drainage system. The tip of the catheter terminating in the cranial cavity was cut off and cannulated with a 20 gauge intravenous (IV) catheter allowing connection to a fluid reservoir or fluid filled syringe. The lumbar drainage catheter was inserted in the customary lumbar region, secured by a transparent adhesive dressing and each end of the tubing was prepared as described above. The instructor has the choice of using a push-pull system with a syringe to create circumstances such as a new hemorrhage from the ventricle, or using a fluid reservoir to simulate fluid drainage and adjustment of the drainage system. The system was reviewed and input was given by a group of adult and pediatric clinicians including a neuro-critical care nurse, a neurosurgeon, an intensivist and a transport paramedic. Creation of a manikin with CSF drainage capacity represents a novel simulation aid that allows teaching skills related to proper usage of these systems. In addition, this system can be integrated with existing high-fidelity modalities which create neurologic changes including pupillary dilation and intracranial pressure numerical values and waveform displays which enable simulation of neurologic emergencies requiring a high level of coordination and rapid response by clinicians. Additionally, further engineering and development of this model will include creation of a simulation aid for insertion of intracranial and intraspinal devices.

Conclusion: The creation and engineering of this manikin allows simulation of a variety of scenarios targeting a number of audiences including acute and critical care nurses, physicians, nurse practitioners and physician's assistants caring for patients with CSF drainage devices. The primary purpose in creating and utilizing this model is to optimize clinician training thereby enhancing patient safety surrounding this high-risk patient care activity.

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Disclosures: Elizabeth Hunt, MD, MPH, PhD, receives grant support from Laerdal Foundation and Hartwell Foundation.

374

A Low Cost Tissue Substitute for Low Fidelity Bench Models Enabling the Use of Monopolar Electrosurgery

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Introduction/Background: Currently only high cost virtual reality or animal models can simulate dissection using electrosurgery/Bovie.[1] Sharp dissection with Bovie 'electrocautery'/diathermy is the most common dissection method used in the real OR environment for both laparoscopic and open surgeries.[2] This technical skill of tissue handing and dissection is poorly addressed currently in low cost/low fidelity simulation models.[3] Sharp dissection with current low fidelity models use scissor or scalpel and mimic the surgical techniques of the last century. Materials can be classified as electrically conductive or insulating. The resistivity of conductive materials is less than 100,000 Ω·cm and the resistivity of insulators are >100,000 Ω·cm. Blood has a resistivity of 150 Ω·cm, muscle 300 Ω·cm and skin >500 Ω·cm.[4] Plastics and all tissue substitutes commercially available are electrical insulators (e.g. latex, polyurethane, ethylene vinyl acetate foam etc) and do not simulate tissue in regard electrical conductance.[5]

Description: A 1:2:2 ratio mixture of gelatin: ethylene glycol: hot water solution produces a stable hydrogel on cooling with a resistance of between 300–700 Ω·cm. By changing the volume of gelatin in the ratio differing amounts of elasticity and texture can be achieved to mimic different tissues (i.e. adipose/parenchyma etc.). By using higher gelatin volumes a harder glue can be made that on reheating can be applied to latex tubes to mimic fibrous/adventitial tissue to simulate dissection around vascular structures or used to simulate dissection of tissue planes. The material is easily colored using food dyes. The tissue substitute has been used at my institution; teaching medical students in the basic surgical skills course (used in suturing and in a low fidelity subclavian central line model). The tissue substitute has also been used with electrosurgery when educating PGY1 surgical residents.

http://www.youtube.com/watch?v=YCrj1DHgM-o

http://www.youtube.com/watch?v=zn2bGVuw6BE

In suturing and procedure models its fidelity is good. Its fidelity with regard electrosurgery is acceptable, however using cut or lower (<35/35) blend settings it liquidizes rather than vaporizes; therefore its thermal properties are not optimal at this stage of development. Its odor on burning is minimal (not organic – slightly synthetic/oily). The shelf life is at least 4 months, however if increasing the ratio of water there is some shrinkage and hardening over the first 2 weeks (which can be used as an advantage when creating a fascia type membrane. Thisharder layer of hydrogel can also be used for suturing and when used in layers with the standard mixture a composite skin is created with a dermis on top of an adipose like tissue thus enabling subcuticular/intradermal suturing.

Conclusion: We have addressed a problem of simulating sharp dissection using Bovie monopolar 'electrocautery' using a hydrogel, which has a considerable cost advantages over animal or virtual reality methods. This conductive hydrogel can be used in low fidelity bench models to mimic human tissue. This is a practical response to a problem encountered teaching medical students and residents and may prove valuable to others. Its advantages are its very low cost thus allowing models to be disposable. This is offset by some lack of fidelity (particularly lack of bleeding) however its fidelity is better than materials currently used in bench models and it removes some of the ethical issues of higher fidelity animal models (although gelatin is made from by-products of the meat and leather industry). The next and ongoing challenge in bench model surgical simulation not addressed with this tissue substitute is the modeling of vascularized tissue with the simulation of small vessel bleeding and the control of hemostasis.

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Disclosures: None

414

Pond Aerators are a Low Cost, Portable Alternative for Providing Positive Pressure in Neonatal Resuscitation Program (NRP) Training

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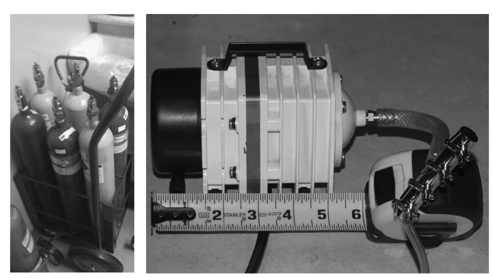
Introduction/Background: The three most widely used devices to ventilate the lungs during neonatal resuscitation are self-inflating bags, flow-inflating bags, and T-piece resuscitators. The newest NRP algorithm includes CPAP for infants making respiratory effort but with labored breathing or failure to reach target saturations,[1] but mask CPAP cannot be given with a self-inflating bag. In addition, careful minute-to-minute titration of oxygen delivery is now strongly recommended for newborns1, and this titration is unreliable with self-inflating bags.[2] However, since many simulation centers, classrooms and other teaching centers do not have reticulated medical gas supply, training is often limited to self-inflating bags. One solution is to bring oxygen tanks. These are heavy, expensive, include the need for a regulator and can distract the instructor and students by the need to conserve gas. An E Cylinder oxygen tank at 2000 PSI would last less than 60 minutes at 10L flow/minute. While 10L flow/minute works in patient care settings, manikins such as the Laerdal SimNewB are leakier and stiffer than real patients, and often one requires a higher flow to produce chest rise. For moderate sized classes, it is advantageous to have multiple manikins in use at the same time. Each E-cylinder tank, by itself, costs approximately $60–$110 for an aluminum tank, and weighs approximately 3.7 kg empty. They are bulky, with a diameter of 7.25 inches and a height of 23.5 inches.(see figure). We describe a low cost, light, reliable, highly portable solution for providing pressurized air, to allow training using anesthesia bags and T-piece resuscitators.

Description: Pond aerators are designed to oxygenate ponds by pumping bubbles. There are a variety of brands, prices, and features, and the smallest of them generate too little flow. For use in neonatal resuscitation training, necessary features for a pond aerator include a minimum of 10L/minute flow, and airflow from the pump that can be regulated. For pumps with a single (sufficient) motor speed but a manifold outlet, partially or fully occluding some outlet ports can achieve this. Many pond aerators have these characteristics and are capable of producing sufficient airflow to drive multiple positive pressure devices. An example of a tested pond aerator available in the Australia and the UK is the "Pond One" PondAir 8000® pump. This compact pump weighs 4.5 kg, produces 70 L/minute airflow, and supports at least four workstations. This model has been used extensively for neonatal resuscitation training in Queensland, Australia by the Mater Mothers' Hospital, including in resource-limited rural and remote hospital settings. This brand is unavailable in the United States, but a similar available product is the Coralife SL-65. Pond aerators are noisier than oxygen tanks. Measurement of sound level of the Coralife SL-65 pump demonstrated a sound level of 68 decibels at approximately 3 feet distance. This was comparable to the sound level of the air compressor on a Laerdal SimNewB (which was 70 decibels at a 3 foot distance). In practice, the sound of the pond pumps is not quiet, but is not so loud as to be distracting. All three kinds of positive pressure devices can be attached directly to the pond pump using a single strategically cut piece of ARGYLE Universal Bubble Tubing. (See Figure)



The figure above shows (left) multiple heavy oxygen tanks required for a simulation session with more than one work station, (right) a Coralife SL65 Pond Pump which can support up to four simulation sessions indefinitely.

Conclusion: Pond aerators are an off-the shelf, inexpensive, safe, portable solution for providing compressed air during NRP training. Compressed air is essential for teaching the use of the T-piece resuscitator and the anesthesia bag, which are the only devices that can deliver PEEP and are the most accurate devices for titrating oxygen delivery. Pond aerators have multiple advantages over air or oxygen tanks in cost, portability, and ease of use.

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Disclosures: None

An Innovative Online Simulation Game for Nurses Pharmacology Training

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Introduction/Background: Knowledge of applied pharmacology is essential for any health professional for promoting good practice and reducing errors. Simulation based training has been proven to be an effective modality to teach in a safe and controlled environment, but has some limiting factors, such as time constraints and high costs. Distance learning (DL) is a good strategy to reach a great number of students at different locations, but adherence and participation can be dependent on effective instructional design. Virtual environments and serious games are attractive to many people, especially due to the interactivity they promote. We created an online virtual environment game to teach clinical pharmacology to nurses.

Description: We designed and delivered a pilot postgraduate nurse education program in the virtual world. Clinical scenarios on applied pharmacology were developed by specialists and their feasibility was also discussed with instructional e-learning developers. The game begins with a nurse's avatar on the screen giving directions about the case. The students are able to decide what task has to be done and how it has to be done at different moments. If he or she makes a mistake, the nurse's avatar directs the student to a consult at a library in the virtual environment and the student has the chance to try again in order to proceed with the case. The students can see the result of their decisions on the screen, receiving immediate feedback. During the progress of the game, students receive bonuses for each right task or decision made. Our main objective was to explore the feasibility of this model of teaching and understand the barriers for acceptance. We measured the participants' feedback through a survey at the completion of the game. We trained and enrolled 20 post-graduating nurses in an hour-long, highly interactive online virtual game on some topics related to applied pharmacology (e.g. how to prepare a medical prescription, how to calculate a solution, how to use an infusion pump, etc.). Participants completed a survey to measure access to the system (via internet), their impression about the virtual environment and usability. All the participants completed the post intervention survey. Users showed satisfaction and acceptability with respect to reliability and management of the scenarios. All the participants agree that this modality of virtual game could be an interesting and attractive method to stimulate learning.

Conclusion: The results of this pilot study suggest that virtual games for teaching postgraduate nurses applied pharmacology has the potential to offer a new modality of e-learning that enhances the feasibility to teach on a large scale. This pilot study doesn't measure outcomes or comparison with other traditional methods. We do believe that, if associated with traditional teaching, virtual games could offer better results as well as be applied to many others categories of students. This hypothesis has to be tested in future work.

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Disclosures: Sergio Gelbvaks, MD, is a consultant. Rodrigo Alves, Bacharel, is a consultant. Marcio Gandara, Bacharel, is a consultant.

3rd Place – Technology Innovations

Oral Presentation

461

Development of Computer-based Simulation and Gaming for Teaching Emergency Medicine in Tanzania: A Resource Limited Environment

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Introduction/Background: Information Technology (IT) has significantly impacted the global community. Additionally, high fidelity medical simulation has emerged in the ever-evolving field of medical education. Current literature clearly shows that medical simulation improves knowledge acquisition by trainees. However, the utility of life-sized, high fidelity medical simulation is reduced in remote, resource limited areas of the developing world due to expense and limited portability. We believe the latest advances in IT and medical simulation can be leveraged to bridge this gap. Additionally, there must be continued efforts to find new ways to improve CPR, ACLS training, and all medical education. Emergency Medicine (EM) is a relatively new specialty in sub-Saharan Africa. As such, Africa faces a shortage of qualified EM educators and dedicated resources to build EM programs. ACLS has become a mainstay for education within the medical community and is currently taught using life-size high fidelity medical simulation mannequins. This current method of teaching, however, is not very portable; particularly in remote areas of the developing world. To address these needs, in collaboration with a local collegiate simulation and gaming program and the 1st Emergency Medicine residency program in Tanzania, we developed a novel computer-based simulation program aimed to facilitate remote training in hopes to improve education, patient safety, and optimize clinical outcomes. We believe this prototype represents the future of EM education in resource-limited settings.

Description: A scenario involving a patient with the cardiac dysrhythmia unstable ventricular tachycardia was chosen for this prototype due to its relatively straightforward algorithmic therapeutic approach and ease of initial programming design. The scenario incorporates evidence based-practice and a large array of user inputs, approximating an actual patient encounter. Using a motion capture suit with LED capture sensors, a technology currently used by advanced commercial gaming operations, we captured and created animations of the simulated characters. Additionally, to enhance realism, characters, equipment, and physical environments were modeled to replicate those specifically found in a standard Tanzanian EM department. This concept is important for both learner buy-in and incorporation of setting-specific tools and limitations. As in many computer games, the learner is faced with a scenario in which one must act and react to data presented in a constant feedback loop. The learner navigates this simulation based upon their current knowledge of appropriate medical resuscitation according to ACLS guidelines. Upon completion, the program can generate a report detailing the trainee's actions for review by an educator. Using IT, the simulation and feedback sessions can be conducted remotely, enhancing the utility of the program in the developing world. Future work will look to study this modality versus standard lecture format as well as expanding on the platform to include additional scenarios and establishing a website to allow global access to remote medical simulation and feedback. It is our hope that this computer-based medical simulation and gaming prototype could be used as a template for additional medical training scenarios.

Conclusion: We believe that new and innovative teaching modalities such as this represent the future of medical education in Tanzania, throughout Africa, and throughout the world.

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513

Continuous Modulation of Airway Resistance in the Original Laerdal SimMan Mannequin

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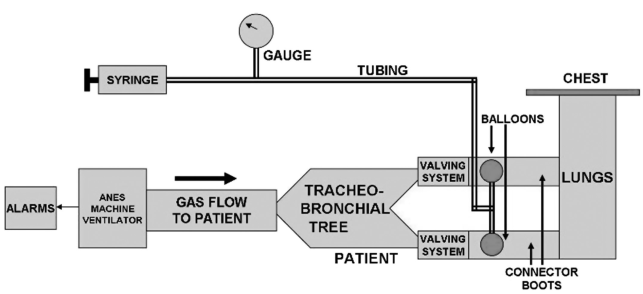
Introduction/Background: The Laerdal SimMan is a popular high-fidelity human patient simulator used in many centers throughout the world. This device is particularly well-suited for anesthesia simulation, as its tracheo-bronchial tree permits examination of second- and third-generation bronchi and realistic placement (and misplacement) of double-lumen endotracheal tubes and bronchial blockers. However, SimMan has plastic bags for lungs that do not allow dynamic control of lung compliance or airway resistance, preventing realistic simulation of common problems encountered during ventilation. Changes in airway impedance can be simulated by modifying SpO_2 and related physiological variables, but anesthesia providers will not feel increased resistance to manual ventilation or see elevated airway pressures triggering the appropriate alarms on the ventilator during mechanical ventilation. Without this feedback, learners may not properly identify and treat the underlying problem. In some systems, binary changes in airway resistance may be used to simulate changes in lung mechanics, but this method does not allow for realistic changes in patient condition. This limitation has been addressed with varying degrees of fidelity in newer Laerdal (SimMan 3G, SimMan -Essential) and METI (iStan) simulators and other systems (PatSim).[1] Less costly options have been described, such as diverting the airway circuit to a separate lung simulator,[2] or even "transplanting" a lung simulator into the chest of SimMan.[3] We describe a simple and inexpensive modification to the original Laerdal SimMan, allowing continuous modulation of airway resistance.



Description: A small rubber party balloon was cemented to flexible tubing from a pediatric blood pressure cuff and pushed through a small hole in the interconnect boot that connects the tracheo-bronchial tree to the valving system (see figure). This procedure was repeated for the second lung. Using a T-connector, the two tubes were attached to a very long thick-walled 3/8"outer-diameter vinyl plastic tube exiting SimMan through a hole drilled in its body. This tube was routed to the operator's console and attached to a 60 mL syringe and an analog pressure gauge. As air is injected, the balloons inflate and the pressure inside the tubing gradually rises to ~60 mmHg, causing near-complete occlusion of the airway. Peak inspiratory pressures well above 40 cm H_2O can be achieved. The relationship between pressure and airway resistance is not linear, but the device can be calibrated if needed. Alternatively, the degree of resistance can be determined by watching the airway pressure on the anesthesia machine and listening for its alarms. If 100% obstruction is needed, the pre-existing "cannot ventilate" valves still operate as usual. This system could be modified for independent control of each lung; but in our experience, restricting air flow in both lungs at the same time has been sufficient. We have used this modification in numerous scenarios where respiratory impedance is increased, such as bronchospasm, pulmonary edema, limited lung or chest wall expansion (e.g., patients with obesity, Trendelenberg positioning, or abdominal insufflation), and even patients with inadequate anesthesia who are "bucking" or trying to breathe against the ventilator during mechanical ventilation.

Conclusion: We have described a simple, inexpensive modification to the original Laerdal SimMan, allowing continuous variable modulation of airway resistance without compromising the normal functioning of the mannequin. Our technique could be used with any other patient simulator whose lungs can be inflated with air to create a pressure-volume relationship over the range commonly used by anesthesia machines or ventilators. We have successfully used this modification to simulate a wide variety of clinical situations involving increased airway impedance.

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Disclosures: None

Oral Presentation

523

Novel Cardiothoracic Trainer to improve Interprofessional Education (IPE) During Robotic Surgery

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Introduction/Background: Robotic assisted coronary artery grafting (r-CABG) surgery provides a totally endoscopic approach to a traditionally invasive procedure. Studies show that the robotic assisted surgical approach shortens patient recovery time and can improve patient outcome metrics compared to standard sternotomy CAGB.[1,2] However, there is a substantial learning curve associated with r-CABG.[3–5] Initial conversion rates to larger thoracic incisions, which are associated with increased morbidity and length of stay, are significantly higher in the first twenty-five cases.[6–8] Cardiothoracic (CT) surgery currently lacks a training model that can reduce the learning curve and prevent patients from being exposed to its harmful effects. Simulation has consistently been shown to be effective in teaching technical and team development skills outside of direct patient contact.[9–13] We custom designed and tested a novel CT surgical trainer to practice conversions from r-CABG to open CABG via thoracotomy in a series of possible emergency scenarios.

Description: Using artificial tissue and anatomic models, we modified a commercially available mannequin torso (Store Fixtures, USA®) to develop a custom robotic CT surgical trainer. Windows were cut for the tissue inserts in the groin and left chest wall of the mannequin. A femoral line replaceable tissue (Simulab Corporation©) was inserted into the groin area. The chest wall insert was custom designed using platinum silicone (Smooth-On, Inc.©), artificial blood (ICU Blood™ Products, Paint and Powder Cosmetic©) and plastic rib bones (3B Scientific©) to provide high realism for a thoracotomy conversion during r-CABG. The plastic rib bones were embedded in the chest wall in anatomically correct position allowing appropriate insertion of thoracotomy chest spreaders. The chest wall tissue was plumbed with artificial blood and designed to bleed upon incision. Lungs and a heart model (Dapper Cadaver©) were placed inside the trainer in anatomically correct position and additional holes were drilled for trocar ports. The trocar ports were made with platinum silicone to simulate real tissue and enhance the fidelity of the trainer.

Conclusion: The model has been successfully employed to test its suitability for insertion of robotic instruments, and its appropriateness for the introduction of guide wires and cannulae for connection to a cardiac bypass pump. It was successfully used for thoracotomy and defibrillation in a r-CABG conversion procedure. According to surveys, 96% (22/23) of participants in the in situ simulation exercise reported feeling more confident about performing the procedure following the training. The bleeding tissue CT trainer provides an effective platform to practice both technical and interprofessional skills in robotic surgery and thus affords an opportunity for practitioners to work through the learning curve in simulation rather than on patients. We report this model because we believe it can prove useful in the future for training minimally invasive robotic and endoscopic techniques.

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528

Development of a Virtual Reality Human Simulation Training Intervention for Health Literacy Appropriate Communication

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Introduction/Background: Health literacy (HL) is defined as the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions. Inadequate communication between providers and patients is correlated with negative health outcomes and poorer quality of life. The patient-provider communication gap also has a brutal economic impact on healthcare and is a significant factor in malpractice cases. Thus it is very important to develop an educational tool to improve communication between healthcare providers and patients. Computer-based virtual patient (VP) programs have been evolving in the past few years, going from text interactions that mimicked written multiple choice tests, including video and audio with the experience. Recently, virtual reality technology has eliminated the burden of recording VP responses, and has thus simplified manipulation of VP demographics and behaviors. Our modern approach on this concept features life-like VP who can exhibit complex facial expressions and body language. We additionally provide opportunities for hybrid interactions where students can select from answers or write in responses they feel would be more appropriate. We hypothesized that an interactive, multi-modal VP training module designed to improve HL sensitive communication skills for health care providers in Training (HCPIT) will lead to improved communication between HCPIT and patients.

Description: The first stage was to develop a content-validated script for the VP after interviewing twenty three health care experts in pediatrics and fifty eight parents of children visiting the hospital. We devised a scenario modeling a conversation between the doctor and father of an infant seen in the emergency room, suspected to have intussusception, a potentially serious intestinal condition. The scenario contained 11 questions/statements posed by the patient's father, each followed by four to six possible responses from the doctor. The questions had responses that varied in complexity and empathy. Subjects were asked to select their most and/or least favored answers and explain their preferences. In addition, a REALM HL test was administered to parents. We have now created a virtual human avatar to fulfill the role of VP in the module. Learners are faced with a life-like, interactive, 3D patient avatar and environment, rather than video or text. It is formatted as a multiple-choice interaction, where an avatar speaks as the patient, and the user selects the ideal answer from the perspective of the doctor. It appears and behaves like a real patient, with facial expressions corresponding to his statements, thereby imitating a natural human interaction, while offering the flexibility and standardization of virtual reality (such as customizable patient, race, gender, disorder). Feedback from the user at each question will automatically be logged into a remotely accessible database. The VP will also present inquiries to the provider that challenge the provider's HL communications skills. This program is designed with the Unity3D Game Engine, and allows for immediate deployment on multiple platforms including Microsoft Windows, Apple Macintosh OS, Apple is (iPhone, iPad), Google Android, and plugins for all major Internet browsers. This approach ensures that the software will be accessible to the largest audience possible, and will enable larger studies into the affect of bias on health communication.

Conclusion: We now have a content of script validated for use in HL VP model. We have now established a single, ideal answer script for each question that spanned across literacy levels and professional backgrounds. Our next step is to further validate the script by administering the VP program to HCPIT and allowing subjects to select their preferred responses and/or provide feedback as to what they consider components of an optimal interaction. Once finalized, this will be used as an educational tool.

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573

Development of an Online Orientation for Second Life

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Introduction/Background: Alternative methods of education, such as simulation, allow students to learn imperative skills, such as critical-thinking[1] and clinical reasoning, while keeping patients free from harm.[1,2] It has been posited that in the future, simulation will continue to play a critical role in skill development.[3] For programs offered exclusively online, such as The University of Texas (UTA) College of Nursing (CON) Academic Partnership Baccalaureate of Science in Nursing (APBSN), resources for physical simulation are limited. *Second Life*® (SL) offers an accessible, inexpensive medium for physical simulation experiences. However, orientation to SL can be a lengthy process.[4] For faculty/academic coaches (MSN prepared faculty that facilitate the didactic portion of the online courses) and students who are only online, additional challenges to orientation may occur. In order to orient these groups and eventually integrate SL into the curriculum, development of all online orientation for both faculty/academic coaches and students needed to be developed.

Description: A group was formed, including an APBSN program administrator, SL experts (faculty/staff), a simulation research expert, and an undergraduate student. The group met and developed an online orientation module consisting of small subsets of content to be delivered over several weeks. Components included: downloading the program software, creating an avatar, navigating/transporting to the college island, locating a school backpack and dressing the avatar for clinical, communicating/friending faculty, completing an asynchronous orientation at the *Virtual Ability Island* within SL, and how to return to SL. An orientation area was then developed in SL by one of the SL experts within the CON's virtual learning space onthe SL platform. Information regarding accessing the orientation was then disseminated to the faculty and students enrolled in the Clinical Nursing Foundations course. The required participants (Lead teacher, clinical faculty, and students) completed the online orientation independently. Posters, arrows, and tutorials were included, so that the orientation process could be done individually. Snapshots of the layout and examples of tutorials were presented.

Conclusion: Although a lengthy process, an online orientation to SL can be developed. Various experts, including educators, administrators, research and technology experts, must be included. The next step is to conduct a research project to evaluate the online orientation usability for both faculty/academic coaches and student.

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727

Learn with a Physiology Simulator: The Value of Pre-oxygenation and the Dangers of Hyperventilation

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Introduction/Background: Bag-valve-mask ventilation (BVM) is a basic skill that is often learned in a simulation environment. While teaching emphasis is often placed on proper technique of obtaining a seal with the face mask, less attention is afforded to the length of pre-oxygenation (de-nitrogenation) and the rate of BVM ventilation. In high fidelity simulation, trainees feel "rewarded" for hyperventilation as oxygen saturation (SpO_2) rises. The potentially detrimental effects of hyperventilation in a critically ill patient are difficult to appreciate on a standard simulation monitor. HumMod (http://hummod.org/), a mathematical model of human physiology[1] developed at the University of Mississippi Medical Center, has been validated as accurately modeling human physiology.[2] We used this program to demonstrate the effects of the following: 1). varying times of preoxygenation on the length to hypoxia when apnea occurred, such as during intubation attempts; 2). different rates of BVM, to get SpO_2 back to 100%, after starting at 80%; and 3). varying BVM rates on alveolar PCO_2, cardiac output and brain blood flow.

Description: To establish a stable baseline for our studies, we used steady-state initial conditions for HumMod. To study the effects of pre-oxygenation, we had the simulator "breath spontaneously" with fraction of inspired O_2 (FiO_2) of 100% for 0, 0.5, 1, 3, 5 and 7 min. To simulate apnea, we turned on the simulated ventilator with a respiratory rate and a tidal volume of zero. We ran the simulator until the program indicated the patient would have died. To compare the effects of different BVM rates, we pre-oxygenated for 5 minutes then simulated apnea as described above. We stopped the simulation when SpO_2 decreased to 80%. We saved this state as the baseline for the subsequent conditions. Starting from this SpO_2 80% baseline, we used the ventilator function with FiO_2 100% and tidal volume of 750ml (volume of BVM) at rates of 5, 10, 30 and 50 breaths/min. We ran the simulator for 5 minutes at each rate and collected vital sign data, cardiac output, brain blood flow, and alveolar PCO_2 data.

Conclusion: Our clinical and high fidelity simulation teaching experience was that once SpO_2 dropped to 80%, most health care providers tended to hyperventilate the patients. Our study on a human physiology simulator demonstrated how pre-oxygenation and different rates of BVM ventilation affect SpO_2, heart rate, blood pressure, alveolar PCO_2, cardiac output and cerebral blood flow. Learners could use this this screen-based simulator as a first-hand experiential learning tool to understand and appreciate the physiological reasons for clinical management guidelines. Such deeper understanding would improve management of critically ill patients when the providers' own stress levels tend to dictate the "pace" of ventilation.

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825

A Simple Fix to Eliminate Sporadic Elevations in Peak Pressure in Ventilated Laerdal SimMan 3Gs

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Introduction/Background: Simulation artifact is unavoidable. Depending on the learner and the desired outcome, minimizing artifact and maximizing fidelity, for certain elements of the simulation, is critical. Anesthesiologists rely on interpretation of clinical signs and data from patient monitors in order to assess and solve problems. Simulation is now a mandatory component of Maintenance of Certification for Anesthesiologists (MOCA), which requires participation in simulation, then reflection on and improvement of practice. Therefore, the mannequin-ventilator interface is one component of simulation for this learner group that must be realistic and reliable.

Description: The authors observed apparently sporadic, elevated peak airway pressures with a Laerdal SimMan 3G that was intubated and mechanically ventilated. The elevated pressures were intermittent and not sustained, causing the participants to become unduly occupied and uncertain of what to believe about the numbers. In recreating the event, we observed that the pressures were only elevated when the mannequin's head was flexed. Flexion of the head resulted in significant kinking and obstruction of the right mainstem bronchus. The anesthesia machine correctly sensed elevated peak pressures, and the obstructed right mainstem bronchus was the source of the simulation artifact. The original right mainstem bronchus of the mannequin is made of a flexible, highly pliable silicone material that kinks easily when the mannequin's head is flexed. The resulting obstruction caused elevated pressures when the mannequin was being mechanically ventilated. Replacement of this piece with corrugated tubing prevented recurrence of the problem. Corrugated tubing (taken from a nebulizer) was chosen as a replacement due to its flexibility, proper diameter, and decreased likelihood of collapsing under flexion. We tested this solution with maximum flexion, extension, and rotation of the mannequin's head, and the tubing remained secure, did not collapse or distort, and has been a reliable solution over 44 MOCA scenarios. This solution has been adopted as a permanent right mainstem bronchus for Laerdal SimMan 3G mannequins in our institution.

Conclusion: Simulation centers requiring high mannequin-ventilator interface fidelity should consider replacement of the original right mainstem bronchus with corrugated tubing. This replacement process can occur at minimal cost. No other internal components of the mannequin are changed, and the original functionality of chest rise with inspiration and adjustable airway resistance through instructor software manipulation is maintained.

Disclosures: None

920

A Modification of Laerdal SimMan 3G Lungs Leads to Improved Mannequin-ventilator Fidelity

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Introduction/Background: High fidelity simulations often require that mannequins be mechanically ventilated. The original configuration of the Laerdal SimMan 3G has significant limitations in its ability to be mechanically ventilated, including inadequate tidal volumes and disproportionately high peak airway pressures. Because high peak airway pressures at low tidal volumes is a sign of a potentially serious clinical problem, most anesthesia providers place a high priority on addressing this perceived problem. This artifact can negatively impact the intended learning outcomes whether or not high airway pressures were a deliberate component of the scenario. With the advent of mandatory simulation for Maintenance of Certification for Anesthesiologists (MOCA), the need for improved mannequin-ventilator interface fidelity is critical.

TABLE 1. A comparison of peak pressures and tidal volumes using original vs. modified lungs.

Machine Settings		ORIGINAL LUNGS		MODIFIED LUNGS	
$V_{T\ (mL)}$	$FGF_{(L/min)}$	$V_{T\ (mL)}$	PIP $_{(cm\ H2O)}$	$V_{T\ (mL)}$	PIP $_{(cm\ H2O)}$
400	2	300	21	360	17
400	10	390	47	540	22
600	2	460	31	550	23
600	10	480	56	630	33
800	2	580	40	750	33
800	10	570	75	800	54
1000	2			820	36
1000	10			860	64

Description: The need for improved fidelity of simulator lung mechanics encouraged the author to seek a solution. In tests with bellows-driven anesthesia machines and the original lungs, desired tidal volumes were not achieved, and peak airway pressures were unrealistically high when a high fresh gas flow was used (Table 1). In two ventilation attempts at tidal volumes of 800 mL, physical damage occurred to the original lung bags. Adding and removing compliance bands on the lung boards had adverse effects on airway pressures and tidal volumes. Changing the original lung bags to 0.75L anesthesia breathing bags (Rusch Medical Ref #210700075) allowed tidal volumes of up to 800 mL with significantly reduced peak airway pressures. A challenge of a 1000 mL tidal volume using the modified lungs resulted in high peak pressures and a failure to attain the set tidal volume. This modification has been adopted as a permanent solution for our mannequins and has been successfully used for more than 50 MOCA scenarios.

Conclusion: This simple change to the of the mannequin can be made with ease and minimal cost, resulting in greatly improved lung mechanics and fidelity. No other internal components of the mannequin are changed, and the original functionality of chest rise with inspiration and adjustable airway resistance through instructor software manipulation is maintained. There are several limitations. The limit of the modification was a tidal volume of 800 mL. This is a physical limitation of the expansion of the lung bag, and cannot easily be overcome due to the fixed free volume inside the thorax of the mannequin. A second limit, identical to the original lung bags, is the inability of the mannequin to generate negative thoracic pressure, simulating a patient initiated breath. The modification process can be viewed at http://vimeo.com/45844903. This modification is intended to simulate a patient receiving positive pressure ventilation. Finally, further testing on piston-driven ventilators machines is currently being completed.

Disclosures: None

957

A Spatial Task for Measuring Laparoscopic Mental Workload

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Introduction/Background: Laparoscopy has replaced traditional open surgery for several procedures. The increased difficulty of this technique, however, may lead to an increased risk of injury to the patient.[1] Dekker and Hugh concluded that some laparoscopic injuries are attributable to cognitive errors including visual-spatial and/or attentional problems.[2] One source of difficulty is that surgeons must operate in 3-D space while referencing a 2-D display. Oculomotor and binocular depth cues are absent in 2-D displays, requiring the surgeon to rely on impoverished pictorial depth cues. Although these deficits in visual information can be overcome with extensive practice, they place significant demands on attentional resources and increase mental workload. We have developed a method to measure the unique visual-spatial attentional requirements of laparoscopy based upon multiple resource theory. According to Wickens, pools of attentional resources are distinguished by: 1) processing stages (perceptual/cognitive and responses), 2) verbal and spatial processing codes, and 3) auditory and visual processing modalities, with the visual modality separated into focal and ambient/peripheral channels.[3] When two or more tasks compete for the same combination or pool of resources, they interfere with one another and increase mental workload. Accordingly, a secondary task was developed to require the same pool of spatial attentional resources needed for determining depth on a 2D laparoscopic display.

Description: The ball-and-tunnel spatial secondary task displays four balls in a simulated tunnel. Changes in the size and position of the balls are used to depict differences in depth, i.e., a ball moving closer or farther down the tunnel. The task is semitransparent and superimposed directly over the primary task display, ensuring that both tasks are viewed within focal vision. Each image is shown for 300 msec and then removed from the screen. Participants indicate the presence of changes in the ball positions by pressing a foot pedal. Performance is measured by itself (single task) and in combination with the primary task (dual task). Secondary task performance (accuracy) is expected to be lower in the dual vs. the single task conditions providing an index of mental workload or attentional resources required by the primary task. In an initial study, the ball-and-tunnel task was paired with a laparoscopic threading task requiring participants to pass a needle through eyelets arranged indifferent orientations.[4] The results showed that performance decreased in the dual task relative to single task condition, suggesting that the ball-and-tunnel task is indeed sensitive to mental workload needed during laparoscopy. The ball-and-tunnel task runs on a standard PC. The system mixes two separate video sources (computer and analog/digital video) into one combined video output. The current system allows the ball-and-tunnel task to be "projected" onto virtually any existing simulator (or camera) image without any modification to the host simulator. This system is flexible, vendor-independent, and enables the ball-and-tunnel task to be used as a secondary task measure across a range of laparoscopic video or simulator displays. The current configuration uses two laptop computer systems and video capture hardware, all of which can fit into a two-notebook travel bag, making the system easily portable.

Conclusion: The ball-and-tunnel task provides an objective index of the mental workload that complements traditional metrics of speed and accuracy on laparoscopic tasks themselves. This task is designed to identify laparoscopic conditions that deprive surgeons of the spare attentional resources needed to multitask effectively in the OR and may help establish a new threshold of surgical competency based on fundamental attentional processes. This technique can highlight potentially challenging conditions that pose concerns for patient safety and can be easily incorporated into training programs to identify when surgical trainees have acquired adequate skills to transition from simulators to the OR.

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2nd Place – Technology Innovations

Oral Presentation

975

An In Situ Tele-mentoring System for Training Endoscopic Surgery in the Operating Room

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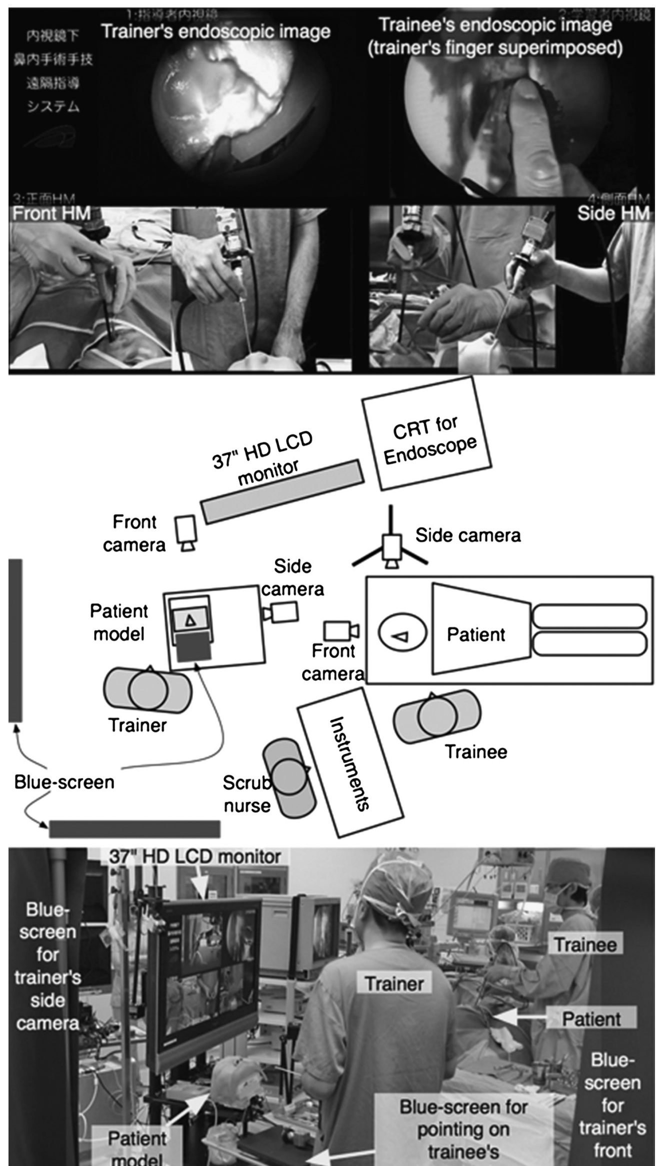
Introduction/Background: On the Job Training (OJT) is indispensable to surgical training. Traditionally, an expert surgeon (a trainer) served as an assistant to a beginner (a trainee) in OJT. However, this is becoming more difficult, since recent low invasive surgery trends toward solo-surgery to reduce personnel expenses. In OJT of endoscopic paranasal sinus surgery (ESS), a typical solo-surgery, a trainer can instruct the trainee only verbally, pointing at the endoscopic monitor. This is very inefficient and can even be dangerous because surgical manual skills can not be described well verbally.[1] When the trainee can not continue the operation, the trainer takes over the procedure. Complications may then take place because the trainer, who just watches endoscopic images, could misunderstand what is actually occur-



ring. To make OJT in solo endoscopic surgery efficient and safe, we developed a tele-mentoring system to be used in the operating room (OR) and conducted an experiment on ESS (1 case) in 2011 at Kansai Medical University (KMU), Japan.

Description: The experiment was approved by Research Ethics Committees of AIST and KMU. The patient gave written informed consent. A precise 3D-printed paranasal model of the patient was developed based on the patient's CT images prior to the surgery. Materials in this model are incisable using clinical forceps [2]. When the trainee performed ESS on the patient, the trainer simultaneously operated on the model using an identical set of surgical instruments in the same OR. Both watched the 37" HD monitor displaying four windows:

- Top left: the trainer's endoscopic image.
- Top right: the trainee's endoscopic image, onto which the trainer's finger/instrument, shot with a small close-up camera under the patient model, was superimposed. Thus the trainer could point at the trainee's endoscopic image.
- Lower left: the front-view HyperMirror [3] (HM) image, a composition of two images, shot with cameras on the top of the patient's and the model's head, of the trainee interacting with the patient and the trainer interacting with the model. The two images were horizontally flipped and superimposed side-by-side so that the trainer and the trainee could compare their postures and angles of their instruments as if they were reflected in the virtual "mirror" in front of them.
- Lower right: the side-view HM image, another "virtual mirror" composition of the two images, shot with cameras on the left side of the patient and the model, using chromakeying (the trainer's image had a blue background that was replaced by the trainee's image). The angle of depression and the insertion depth of instruments could be compared on this image.

Conclusion: Superimposing the trainer's forceps image, the same kind being used by the trainee, on the trainee's endoscopic image was very useful. Fine movement of instruments on the actual patient's endoscopic image could be taught very easily simply by showing it. The model was so precise that anatomical landmarks could be identified endoscopically. The trainee could show a matched endoscopic image of the patient and the model thus worked as a 3D surgical navigation. After identifying such important landmarks as the lamina papyracea and skull base on both endoscopic images, the trainer resected these dangerous parts on the model and showed the orbit and brain filled with wool. Thus the trainee could safely learn spatial/anatomic limits of the procedure and see complications demonstrated on the model and compare to real anatomy. The system can provide safe and effective OJT for young surgeons; however, development time and costs of patient specific models should be reduced for its frequent use.

Acknowledgment: This study was supported in part by the Japanese Foundation for Research and Promotion of Endoscopy Grant 2010.

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Disclosures: Juli Yamashita, BSc, is a stockholder/partner/owner of SurgTrainer, Ltd., Japan.

1057

Variation of the Oral Cavity to Increase Fidelity of Emergency Simulation Training

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Introduction/Background: One-third of all medico-legal claims against anesthetists result from damage to the dentition.[1] Injuries to the oral cavity and teeth can occur during routine intubation and general anesthesia, but tend to occur in already diseased dental structures.[2] Studies have cited the importance of pre-surgical inspection of the oral cavity and evaluation of anatomic variations as well as the use of dental shields to decrease trauma and injury.[2] During endotracheal intubation, dental injuries occur up to 12% of the time credited to poor technique, difficult intubation and emergency situations.[3] In an emergency situation, securing the airway is the priority before the dentition,[3] which may lead to dental trauma possibly adding obstacles to the emergency. This study examines the feasibility of creating dental modifications to already existing simulation manikins increasing the fidelity of medical emergency simulation training.

Description: The Laerdal Simulation Manikin was utilized in this study to evaluate and manipulate the pre-existing Polyester (hard) and the Vinyl (flexible) dentition sets that are supplied for $30 and are interchangeable between the Laerdal ALS Simulator Manikin, SimMan, SimMan3G and SimMan Essential. Alterations of the Laerdal polyester dentition set were completed to simulate common dental traumas encountered during intubation such as a fracture, luxation or avulsion injuries all which have the potential risk of aspiration of teeth. For example, the left central incisor from the Laerdal dentition set was removed and a replacement tooth was fabricated out of Bis-GMA acrylic. When excess pressure is placed on the dentition during direct laryngoscopy, the fabricated tooth can simulate a luxation or avulsion injury. Another variation to the dentition set utilized spacers on the internal surface of the hard palate to simulate a Class II (overbite) alocclusion. Simulation of airway management during a code was performed and evaluated for dental trauma. Several successful intubations with no dental trauma occurred as well as several intubations when only minor luxation injuries were recorded. Avulsion injuries were also recorded which aided in simulation of retrieval of teeth from the airway during intubation.

Conclusion: This study demonstrates the feasibility and proof of concept of fabricating and implementing anatomical variations of the dentition as a means to increase the fidelity of already existing simulation manikins. The alterations of the existing dentition sets help simulate real life conditions where patients have teeth in

poor repair that are susceptible to injury during intubation, especially in emergency situations where pre-assessment cannot be performed. Further alterations of the oral cavity and head and neck anatomy can consider anatomic variations like dental malocclusions, limited mouth openings, low palatal vaults, or short distances between the temporomandibular joints.

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Disclosures: None

1093

Simulating Electrosurgical Smoke and Odor to Enhance Perceived Realism

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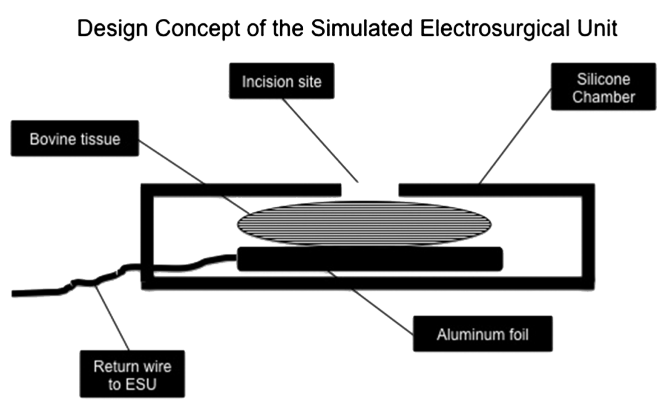
Introduction/Background: Fidelity has been identified as an important element in a participant's perception of realism and engagement in learning during a simulation experience.[1,2] Fidelity describes how accurately reality is represented in a simulation. For a participant in a simulation exercise, three kinds of fidelity (physical, conceptual and emotional/experiential) combine to produce a perception of realism for that individual.[1] Considering the perceived realism, an individual must decide if he or she can engage in a meaningful learning experience.[3,4] Thus, improvements to simulation fidelity may affect the quality of participants' learning experiences. In this abstract, we introduce technology that provides visual and olfactory cues to improve physical fidelity during operating room simulation cases.

Description: Using an electrosurgical unit applied to bovine muscle tissue, we created a model to simulate the characteristic operating room smoke and burning odor that occur during many procedures. A custom-made silicone device was constructed to simulate a surgical wound for the abdomen. The design concept of the simulated electrosurgical unit (ESU) is shown in Figure 1. A simulated incision with the capability for electrosurgery was constructed. A polypropylene container approximately 12 cm × 20 cm × 2.5 cm was half-filled with 2-part platinum silicone rubber compound (Dragon Skin 10 FAST, Smooth-On Corp., Easton, PA) and colored with a flesh tone pigment. A slightly smaller polypropylene container approximately 11.5 cm × 19.5 cm was placed in the silicone compound and weighted until the liquid rose up along the sides of the first container. An electrical wire was placed in the liquid such that one end extended out the side and the other extended out the top. The rubber was allowed to cure and demolded leaving a shallow basin with a 0.5 cm wall thickness. An alligator clip was soldered to the wire within the basin and the other end fitted with a connector that would attach to the return pad port of an electrosurgical device. A top for the basin was made by pouring the flesh toned platinum silicone into a polypropylene container that was slightly larger than the previously constructed basin. A slit was cut into the top to mimic an incision, and it was glued to the basin using silicone adhesive. Deep red-blue foam rubber was fitted into the covered basin such that a well was formed above the alligator connector. A 6 cm square of aluminum foil was cut, seated at the bottom of the well within the basin and attached to the alligator clip. Once the simulated incision was complete, it could be laid flat on a mannequin and draped as if surgery were being performed. For each simulation scenario, a 1-2 cm thick slice of bovine muscle tissue was cut to fit within the well of the foam rubber cover the aluminum foil. A confederate surgeon could then dissect as well as cut and coagulate with an electrosurgical knife.



Conclusion: In a high-fidelity simulation environment, we were able to augment the physical fidelity of simulation exercises to reflect the characteristic smoke and odor associated with electrosurgery. This can be applied widely to simulated operating room where electrosurgical units are used, either for anesthesia or surgical training.

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1229

An Application of Digitized Data of Human Trajectory and Conversation During Medical Emergency Treatment for Simulation-based Clinical Education

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Introduction/Background: In the area of simulation in medical education, there have been many usages of videorecordings of training sessions conducted in a simulation lab.[1] They are indeed a useful tool for reflecting on what is done and what is learned in the simulated session. However, its use is limited as it only captures what the trainees did without having to propose ways of effective evaluation of their performance by using such video recordings. Then, we propose to use the data of actual treatment as a model for simulated education by which we can establish more effective and practical evaluation system. The technology developed by the authors allows the participants to record not only the scene of medical treatment but also the digitized data of conversations and human movement within an emergency room. By the digitized data, we are able to see the participants' movements and conversations, simultaneously, during the treatment and make evaluation of their performances. Thus, this system enables the medical professionals to give suggestions and constructive feedback by comparing the simulated performance with the most realistic model.

Description: In order to implement this system, we have mounted four 3D cameras on the ceiling inside the ER to capture the actual treatment at an emergency department of an urban medical school in the Tokyo area. By capturing the distance towards each object, this camera has made it possible to automatically extract the positional information of every medical staff within the capturing frame, and thus able to reproduce each participant's trajectory. We specifically focused on the initial phase of CPR treatment and labeled the kind of medical treatment performed on the trajectory data, frame by frame. These labels include: airway maintenance, venous root establishment, cardiac massage, etc. In addition, we have transcribed all the conversations recorded during the treatment and labeled the speaker and the addressee of each utterance, speech act (e.g., request, directive, etc.), and the sequence of utterances for each transcribed conversational data. Finally, we have combined the trajectory data and the conversational labeled data (Figure 1). Around a medical treatment bed located in the center of a room, the position of each medical staff, medical treatment labels, the speaker and the addressee, and the type of each utterance are marked in the two dimensional trajectory data.

Conclusion: Thus far we have digitized forty-two actual cases of medical treatment of emergency treatment for critically ill patients. Two dimensional animation is used for resident on-site education by which residents can reflect on their own medical performance in comparison with the modeled data. Our further aim is to apply this technology to simulated education and aim at the implementation of more effective simulated education for doctors-in-training by using the innovative tool.

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Disclosures: None

3rd Place – Technology Innovations

Oral Presentation

1363

Testing a Hand Hygiene Compliance Monitoring System Utilizing a Depth-Sensing Camera in a Simulated Clinical Environment

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Introduction/Background: Hand hygiene (HH) is the single most important action to prevent the transmission of healthcare-associated infection.[1] Alcohol-based hand sanitizers (ABHS) have become the HH choice, and dispensers are prevalent throughout most hospitals, convenient to use, and readily available (dispensers in hallways, pocket-size containers). The gold standard for measuring hand hygiene compliance (HHC) is direct (human) observation, an expensive and laborious endeavor. Electronic systems have been developed for use in hospitals to measure HHC, such as sensors attached to healthcare workers' (HCW) badges and sensors in ABHS and soap dispensers. Many systems are costly, prone to unacceptable error rates, and cumbersome. Advances in the field of machine vision (the use of surveillance) are providing results that are as reliable as direct observation. We developed a HHC system using surveillance that tracks the movement and direction of each HCW on entry or exit and tested it in a simulated examination room during a standardized patient (SP) encounter.

Description: A depth-sensing camera was strategically placed over an ABHS dispenser in a simulated examination room. Depth and image data generated were analyzed by the HHC system's algorithms to recognize outlines of people (without identifying them) and track their movements through the entryway as they passed an ABHS. Each person entering or exiting the room was given a unique identifier by the system and HHC was recorded. Encounters showed individual providers inside a red circle, which changed to green when ABHS is used. To validate the depth-sensing camera, an observer also recorded HHC upon entrance and exit of the room by watching an independent video recording from a camera placed behind the SP capturing the ABHS, as well as the rest of the room in case the student used their own ABHS out of range of the depth-sensing camera. The data from the HHC system and the observer were compared with video recordings of each SP encounter to determine the accuracy of both methodologies. Daily review of the video recordings allowed for adjustments to decrease errors, such as adjusting the depth-sensing camera to capture shorter individuals. The study was given exempt status from the university's Institutional Review Board. A total of 649 events (entries and exits) over 3 days were recorded by the HHC system. Since the system was triggered by anyone entering or leaving the room, we excluded the events of non-students (staff, housekeeping, etc.). We compared the HHC system with the observer and video data and also excluded any events that did not have the entry/exit with complete video capture. There were 218 complete entry/exit data groups that were analyzed. Initial data showed the HHC system had two errors on entry that occurred when students placed their hands near the shelf under the ABHS, but not to use it. The observer made 4 errors, 1 on entry and 3 on exit. These occurred when HHC was performed but was recorded as failure to comply –presumably because the observer was distracted. The HHC system was accurate 216/218 (99.1%), and the observer was accurate 214/218 (98.2%) (NS).

Conclusion: Using a depth-sensing camera, machine vision-assisted observation provides accuracy and accountability. This is a novel use of simulation as a test-bed for new technology. While this requires further study and development, there is potential for organizations to use it in deploying an economical, reliable, virtual observer to track HHC. Testing in a clinical environment is the essential next step. With this type of technology, real-time aggregation of HH data in dashboards will yield useful information about HHC while providing a powerful tool to affect the behavior of HCWs.

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Disclosures: None

Oral Presentation

1367

An Interactive iPad Simulation of Torso Ultrasonography

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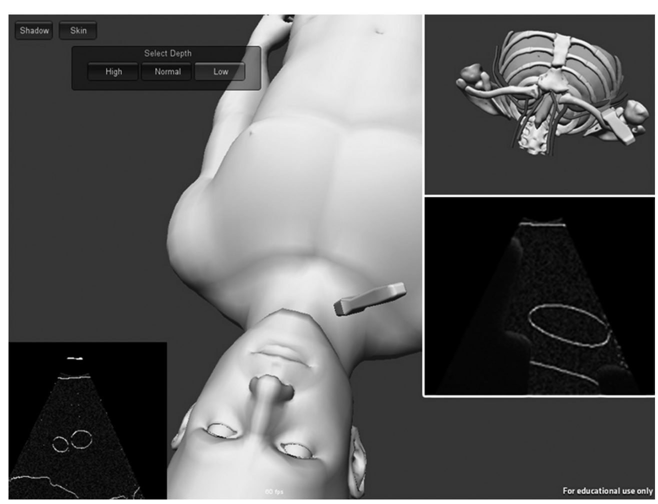
Introduction/Background: Ultrasonography (US) is a complex, high level skill that depends, among others, on a set of fundamental aptitudes such as sound knowledge of anatomy, proper interpretation of a cross-section (what an ultrasound scanner and other medical imaging modalities such as MRI produce), spatial ability in 3 dimensions and relinquishing an egocentric perspective (interpreting the US image not from the perspective of where one actually is but from the vantage point of the US probe). Guiding a needle or other instrument via ultrasound imaging can add another level of difficulty to an already complex real-time task, especially if the needle is not properly aligned to the imaging plane and does not have an echogenic tip. The recent availability of pocket-sized, personal ultrasound imaging devices[1,2] has led to speculation that they might become as common as personal stethoscopes and eventually replace them. To the extent that there may be room for improvement in the training of clinicians in the use and interpretation of US imaging/guidance, the potential proliferation of US imaging that might be ushered by the advent of pocket-size US scanners might also increase the frequency of misuse/misdiagnosis and thus increases the urgency to provide and/or enhance such training as well as accessibility to training. Simulation can be a useful training tool for achieving competence in interpreting and using ultrasound imaging/guidance.[3] Commercial ultrasound simulators such as Heartworks (Inventive Medical Ltd., London, United Kingdom) and Vimedix (CAE Healthcare, Sarasota, FL) already exist but these relatively expensive simulators are generally tied to a mannequin and housed in simulation centers that may limit their portability and/or accessibility. The advent of affordable mobile computing devices such as the iPad (Apple, Cupertino, CA) has led to their rapid adoption by clinicians (for example, all residents in our anesthesia residency program are provided an iPad) and also the sales personnel of healthcare companies. We implemented an US simulator optimized for the iPad 2 display such that clinicians could have individual simulators available 24/7 at their fingertips and increase the likelihood of the simulation being used at the point of care or during "teachable moments."

Description: The simulation was optimized for the iPad 2 touchscreen display. Users move a 3D ultrasound probe directly via their fingers (instead of a pointing device) over a 3D (140,715 polygons) representation of an anatomically correct torso (obtained from a 3D scan). Users can select the depth of imaging and whether to display the torso with the opaque skin on or removed so that the 3D lungs, bones and major vessels become visible and color coded (top right of figure). Similarly, users can toggle between having bones cast shadows or not and can also opt to have a noisy or clean US image. The US images are generated in real time from the 3D anatomical model instead of having predetermined, discrete cross-sections stored in a library and using the slice that matches best to the probe position and orientation. A video of the simulation can be viewed at http://vam.anest.ufl.edu/videos/UltrasoundiPadSim.wmv.

Conclusion: Even though it was handling a 3D torso with complex internal structures and generating the cross-sections on the fly based on the ultrasound probe



position and orientation, the simulation was able to achieve a refresh rate of about 15frames per second. We have demonstrated that an iPad2 can generate cross-sections with no noticeable delay from an anatomically correct 3D model in an ultrasound simulator.

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1384

Developing a New Model for Diagnosis and Treatment of Pneumothoraces in the Neonate

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Introduction/Background: Pneumothorax is more frequent in the neonatal period than at any other time in life. Spontaneous pneumothorax is present in 1% to 2% of live births. Of affected infants, approximately half of them are symptomatic.[1] Timely diagnosis and management of pneumothoraces are necessary skills for neonatal care providers. There are several diagnostic tools used to identify and treat this potentially life-threatening event. Chest radiography is routinely used, but the time it takes to get results may not be ideal. Transillumination of the neonatal chest with a fiber optic light probe placed on the chest wall can transmit brighter light immediately in the presence of a significant air leak. Therefore, transillumination has been found to be a valuable diagnostic aide. Treatment of pneumothoraces may require needle decompression or chest tube placement. Although pneumothorax is fairly common in neonates, symptomatic pneumothorax occurs in 0.08% of all live births and in 5% to 7% of infants with birth weight of ≤1500 grams.[2] Therefore, it is important for neonatal care providers to refresh their skills in diagnosis and treatment regularly. Simulated medical scenarios are one way to practice the cognitive, technical and team skills to effectively and efficiently manage pneumothoraces. High-fidelity neonatal simulators offer limited cues such as decreased breath sounds for diagnosis of pneumothoraces; however, they cannot be realistically transilluminated. Furthermore, currently available high fidelity neonatal mannequins can only accommodate needle decompression but not CT placement. Inexpensive low fidelity neonatal task trainers with realistic landmarks to practice the skills of needle decompression and chest tube placement are not currently available. To address these deficiencies we have created a simple, low cost way of altering one high-fidelity infant mannequin to create a realistic, illuminating effect under the infant skin surface during transillumination. In addition, we have developed a low-fidelity infant task trainer with palpable rib landmarks to teach the skills of needle decompression and chest tube placement.

Description: The high-fidelity simulator utilized was the Laerdal SimNewB™. The mannequin was enhanced to allow for realistic transillumination by securing black vinyl on the inside of the mannequin skin on the side opposite the pneumothorax. Double-sided tape was used over the entire surface of the vinyl to prevent any illumination between the vinyl and the mannequin skin. A low-fidelity infant mannequin in disrepair was used to create the needle decompression and chest tube task trainer. Internal components in the chest were removed and replaced with a full ribcage from a hard plastic skeleton. The ribcage was secured with wire and hot glue. Air-filled balloons were placed in the anterior chest cavity and foam was used between the balloon and posterior ribcage to create a realistic anterior pneumothorax. A transparent plastic sheet was placed over the ribcage and secured to the existing mannequin hooks. Finally, flesh-colored fabric skin was hooked over the plastic. The "skin" may be lifted independently allowing the learner to visualize chest tube placement through the plastic. The enhanced high-fidelity mannequin and low-fidelity task trainer have been well received during field-testing on many different learner groups such as pediatric residents, neonatal nurse practitioners, and community health care providers.

Conclusion: Our modification made to the high-fidelity infant mannequin allows for realistic transillumination. The addition of the described low-fidelity task trainer provides a realistic model for use in simulating needle decompression and chest tube placement. These are simple and inexpensive modifications which when used in conjunction add great value to the simulation learning experience.

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Oral Presentation

1393

Interventions to Improve Mechanical Ventilation Fidelity of the Laerdal 3G Manikin

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Introduction/Background: The widely used Laerdal SimMan 3G manikin is designed for high fidelity during both bag and mechanical ventilation and allows adjustments of compliance and resistance for each lung. However, measured tidal volume is significantly smaller and lung compliance is lower than what would be expected in a human of his height. This is commonly noted during simulation sessions and has repeatedly led to confusion among experienced participants. Moreover, the stock manikin is unable to tolerate higher levels of PEEP. In addition, high airway pressure have led to lung rupture and tubing disconnections inside the manikin. The latter is aggravated if CPR is performed, since the tubing is internally attached to the chest wall of the manikin.

Description: We investigated interventions to address the above noted problems. Fidelity and tolerance of different tidal volumes and PEEP settings were evaluated by serial measurements of inspiratory and expiratory tidal volumes, resulting airway pressures, and calculated static compliance over a wide range on ventilatory settings on a Maquet Servo-i ventilator. We then evaluated the effect of: (1) fitting of larger bags inside the simulated lungs of the manikin; (2) attachment of satellite ventilation bags of different sizes and types with a Y connector to the circuit outside of the manikin, (3) replacement of the internal connection tubing with a longer piece of tubing, (4) Removing the attachment of the internal connection tubing from the chest wall of the manikin to avoid dislodgement during CPR. Serial testing revealed that the stock manikin is unable to tolerate tidal volumes in excess of 700 ml and PEEP of more than 5 cm H2O with peak airway pressures below 40 cmH2O. Beyond these values, airway pressure curves were as well distorted. Static airway compliance of the stock manikin is about 30 ml/cmH2O, 25% of typical human values. Adjustment of compliance and resistance settings via manikin software led to appropriate changes in these values; we did, however, note only minimal difference with the step from compliance "2" to compliance "3". All four interventions led to marked improvements in fidelity and robustness with minimal cost, with specific advantages and disadvantages for each: (1) Replacement of the bags inside the bellows (lungs) of the manikin led to higher fidelity regarding compliance during ventilation, tidal volumes, airway pressures and PEEP. We obtained best results with the use of 0.5 L bags. The possibility to adjust resistance with the controls of the manikin was preserved. Disadvantages are that care must be taken to avoid entangling of the larger bags with the bellows mechanism and that this intervention may void the warranty. (2) Addition of a satellite airway bag via a second y piece to the breathing circuit increased lung compliance to within 20% of physiologic values and allowed ventilation with tidal volumes above 1000 ml and PEEP in excess of 15 cmH2O. Using this method, ventilation can be adjusted by using external breathing bags of different sizes, and no manipulation of the manikin is required. We made best experiences using a 1000 ml bellows as used for ventilator testing. Disadvantages were lower fidelity due to the additional tubing, which can be hidden behind the ventilator, and impossibility to use the manikin's compliance and resistance setting with external bags above 1000 ml. (3) and (4) in combination with stronger cable ties reliably prevented tubing disconnect inside the manikin.

Conclusion: Fidelity of the Laerdal SimMan 3G manikin undergoing mechanical ventilation can be substantially enhanced with above interventions. This is advantageous with experienced providers, an important consideration for the recertification of anesthesiologists. These interventions improve as well the robustness of the manikin.

Disclosures: None

1st Place – Technology Innovations

1395

An iPad Simulation of Skin Prepping

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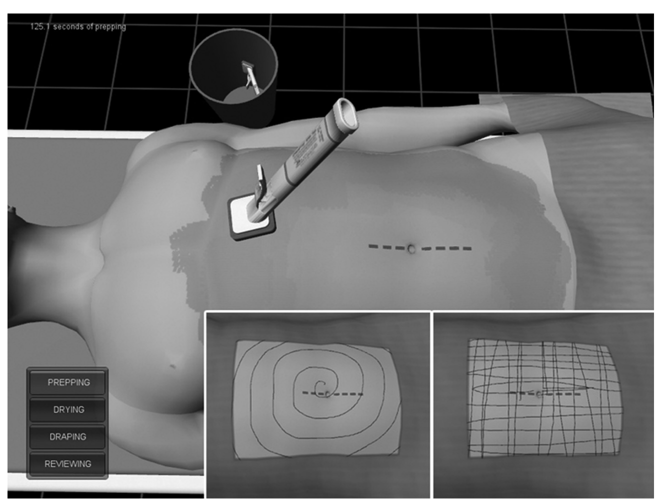
Introduction/Background: Hospital acquired infection (HAI) is a major patient safety concern that includes surgical site infection.[1] Incorrect skin prepping techniques that do not thoroughly disinfect the skin, for example prior to surgery or central venous access, are suspected to be contributory factors to HAI. To better sanitize the skin and effect some defoliation, modern skin preparation practice has evolved to using "repeated back-and-forth strokes of the sponge for approximately 30 seconds" [2] rather than making an outward overlapping spiral (Figure, left insert). The "back-and-forth" technique (Figure right insert) requires experienced clinicians to unlearn ingrained habits such as the traditional outward spiral scrubbing pattern, a learning/unlearning task that we believed might be facilitated by simulation. Tablet computers such as the iPad (Apple, Cupertino, CA) have become popular with clinicians; their small footprint and instant-on capability have promoted their adoption and a transition away from traditional laptops and netbooks. The portability and popularity of tablets increase the likelihood that a simulation customized for a tablet might be at hand when bedside or point of care learning or instruction might occur or be needed. We consequently converted and enhanced an existing simulation of skin prepping previously developed for Windows laptops with Director (Adobe, San Jose, CA)[3] so that it would run on an iPad 2 and include a contoured 3D body surface (Figure).

Description: The simulation was optimized for the iPad 2 touchscreen display to convey the following learning objectives as it relates to skin prepping for an intended midline abdominal incision with a 26 ml applicator that uses a chlorhexidine gluconate (2% w/v) and isopropyl alcohol (70% v/v) solution as the disinfectant (ChloraPrep®, CareFusion, Leawood, KS): use a back-and-forth motion of the applicator instead of an outward spiral trajectory; scrub for at least 30 seconds with the applicator, allow at least 3 minutes for the alcohol in the disinfectant to dry before draping (to minimize the risk of surgical fires) and drape such that the exposed skin is less than the maximum coverage area if only one applicator is used. An automated scoring algorithm was developed so that an objective and consistent score is automatically generated immediately after a simulated skin prep procedure, including a detailed breakdown of the score and a graphical record of the applicator path to provide debriefing feedback to the trainee about what was done well and what could be improved. Multi touch feature was used. A substantive user interface difference compared to the laptop is that users use the iPad touchscreen feature and move the applicator directly via their fingers over the 3D representation of the abdomen instead of via a pointing device such as a mouse or trackpad. A video of the simulation can be viewed at http://vam.anest.ufl.edu/videos/SkinPrepiPad.wmv. The 3D representation (including the 3D applicator) made use of 63,318 polygons.



Conclusion: The standardized configuration of the iPad hardware and operating system (compared to the many different permutations and combinations of video display resolution, graphic card capability, RAM, CPU speed, OS, font set, color palette, etc. in a Windows laptop) facilitated development of software that takes full advantage of the iPad processing power and optimization of the skin prep simulator, while ensuring a stable platform for all users.

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1424

Using Wireless Computer Technology to Maximize the Efficiency of a Simulation Program

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Introduction/Background: During our annual patient safety course, we introduce nearly 350 medical students and interns to patient safety practices such as teamwork, communication, hand hygiene, and situational awareness. A critical component of this training is focused debriefing of simulation encounters where faculty have the opportunity to reinforce patient safety messages with the trainee. With the large volume of participants during this one-week period, the debriefers are unable to observe all the simulation exercises in real-time. Therefore, we used trained observers who recorded key points of learners' performances and transmitted them to the debriefers using wireless computer technology (iPads Apple, Cupertino, CA). In this study we piloted a new data collection system to streamline the delivery of participant performance data to the debriefers.

Description: Three-hundred and fifty medical students and interns participated in a standardized patient (SP) encounter. Participants were given two minutes to complete a focused exam while being observed on a monitor using live video feed. During the encounter, the students were expected to complete four tasks: hand hygiene before and after the patient encounter, ask the patient about the face mask that she was wearing, to remove the mask, and ask about a bruise underneath the mask. Using iPads, the observers scored each participant and transmitted their assessment either electronically using a five-question I-form survey or manually on index cards. The data were either sent via e-mail to two local computers at debriefers' workstations or hand delivered to them. Our results showed that the use of iPads significantly improved course efficiency by reducing time required for data collection by 50% as well as streamlining data entry. The need for post-course data entry was eliminated, which saved 8.5 hours (derived from calculating the time it takes to input each card: 90 seconds per card × 350 cards). As a quality assurance measure, data were analyzed to measure observer accuracy by comparing a sample of 55 electronic surveys to manually completed data cards and video recordings of simulation encounters. The data showed two discrepancies in recording proper hand hygiene compliance, which were seen on both the electronic surveys and the manual cards, suggesting that the discrepancies stem from observation errors whereas transcription accuracy is 100%.

Conclusion: The use of wireless computer technology during our annual patient safety course significantly decreased the time required for staff to provide observational information to the debriefers in real time. Data from the electronic forms were automatically updated in an Excel spreadsheet every 30 seconds as they were simultaneously submitted to the debriefers. However, human error played a role in incorrectly scoring two participants' hand hygiene on both the manual data collection cards as well as on the electronic iforms. Manual data collection works well with small group simulation when the debriefer is also the observer; however, the use of electronic forms maximizes program efficiency, eliminates transcription errors, and makes data readily available for analysis when faced with large numbers of participants. The next step in improving the electronic data collection system will be to create a wireless computer room that will identify the completion of various tasks by participants which would then be sent directly to the computer thereby eliminating human errors altogether.

Disclosures: None

1603

The Creation of an Isovolumetric Exchange Transfusion Task Trainer

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Introduction/Background: Although neonatal jaundice remains a common diagnosis, severe hyperbilirubinemia resulting in kernicterus has become a rare occurrence. At bilirubin levels beyond a threshold, or with signs of acute bilirubin encephalopathy, exchange transfusion is indicated. Performing a successful exchange transfusion requires a multitude of steps, and complications carry significant morbidity and mortality. In addition, in the current clinical and training setting, pediatric residents may finish training without ever having performed an exchange transfusion. We present a simple, cost-effective technique to build a task trainer for an isovolumetric exchange transfusion.

Description: An incision was made at the anatomical site for an umbilical cord on a standard skin flap of a high-fidelity simulation mannequin. A prosthetic umbilical cord was passed through this incision and then through an exit site at the mannequin's flank. Standard umbilical arterial and venous catheters were passed into the prosthetic umbilical cord, and IV catheters of similar size were attached at the distal (internal) ends of the umbilical catheters so to create waterproof connectors. These IV catheters were then connected to two reservoirs: one for collection of infused "donor" blood (umbilical venous line); the other for removal of "patient" blood during the procedure (umbilical arterial line). The external ends of the umbilical lines were connected to an exchange transfusion kit in standard fashion. The task trainer along with a setup checklist was beta-tested by the study group to ensure accuracy and realism.

Conclusion: With this technique, a cost-effective task trainer for isovolumetric exchange transfusion was created. After the initial construction, the task trainer was found to be self-contained, mobile, easily stored, and reusable. Thus, it is feasible to utilize this model in scheduled and impromptu sessions in pediatric residency training programs as well as in non-academic settings for the purpose of skill maintenance by pediatric providers in the field. With the integration of this system into a simulation mannequin, the task trainer can be used to address the different needs and skill levels of various health care providers including those who need to learn how to set-up for an isovolumetric exchange transfusion to those who need practice in performing this procedure and managing its possible complications. In addition, the task trainer can be easily adapted to high-fidelity simulation scenarios to allow for multidisciplinary simulation team training for physician, nursing, and ancillary staff so to identify targets for improvement in point-of-process care during isovolumetric exchange transfusion.

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Disclosures: None

1662

The Electronic Data Generation and Evaluation (EDGE) Platform for Laparoscopic Skills Training and Evaluation

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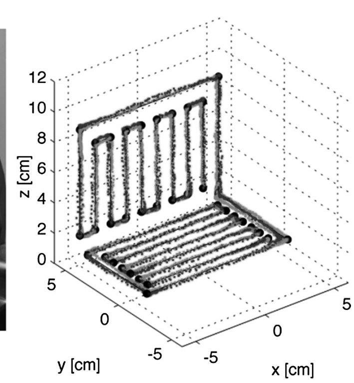
Introduction/Background: Simulation is a valuable tool in training laparoscopic technical skills, a crucial prerequisite for successful surgical training. A plethora of virtual reality (VR) trainers aim to meet this need along with their reality-based (RB) counterparts, such as the widely adopted and validated Fundamentals of Laparoscopic Skills (FLS) system.[1,2] VR trainers offer quantitative analysis but suffer from high development cost and substantial effort to simulate new procedures. RB trainers are substantially lower cost, use real surgical tools on real wet-lab or dry-lab physical models, and promptly adapt to any new skill exercise. Yet, they lack the automated, immediate feedback or quantitative rigor native to VR counterparts. Ideally, a simulator should combine the benefits of VR and RB trainers, notably accurate measurement, immediate evaluation feedback, quick integration of new procedures or anatomy, and avoid high cost. Prior art fails to do so. Instrumentation schemes such like ICSAD[3] and ADEPT[4] provide a means of precisely tracking surgical motion but lack tool-tissue force information or a computer system, which conveniently accrues, processes, or displays skill evaluation information. The ProMIS[5] system offers some performance metrics like tool path length, but still lacks tool force information and suffers from limited accuracy due to the computer vision-based position sensing it adopts. We introduce an instrumented, laparoscopic RB simulator which aims to combine the benefits of VR and RB trainers. Most notably, it can measure and record tool force information from any desired dry-lab task. This enables novel quantitative research for metrics and curriculum design in the area of force use characteristics.

Description: The University of Washington BioRobotics Lab developed the Blue- and Red-DRAGON mechanisms[6,7] and Hidden Markov Modeling quantitative skill evaluation software approach[8] to provide quantitative measures to laparoscopic educators and researchers. These technologies were combined and commercialized as the Electronic Data Generation and Evaluation (EDGE) platform (Simulab Corporation, Seattle WA). The EDGE mechanism accurately tracks the position (x,y,z in cm), orientation (degrees), grasp angle (degrees), and grasping force (Newtons) of two off-the-shelf laparoscopic tools as they interact with any reality-based task at 30 Hertz. It automatically starts and stops procedures and data collection based on tool location and records synchronized video of each task. In addition EDGE software provides data logging, data management, and real-time quantitative skill evaluation and immediately computes and displays a configurable variety of performance measures, including a Hidden Markov Model-derived metric. A battery of diagnostic tests reveals the tool tracking can detect tool tip position movement thresholds as low as 0.095 mm, rotation at a resolution of 0.056 degrees, and grasping force at a resolution of 0.036 Newtons in a range between 0 and 40 Netwons. To verify the positional accuracy in a typical laparoscopic workspace, a rectilinear 3D-toolpath block



was manufactured and traced with the EDGE. Results indicate the recorded tool path overlays the actual target as expected throughout the entire space (see Figure 1). The system has been successfully used in capturing over 23 hours of continuous video from over 90 surgeons at three geographically distinct sites.

Conclusion: We conclude EDGE is an accurate laparoscopic data acquisition system that can provide valuable data for research in laparoscopic skill metrics and simulation curriculum design. It addresses a gap among VR and RB trainers. We are currently studying if its automatic evaluation and immediate feedback are shown to aid or accelerate training.

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1667

Transvenous Pacer Insertion A Using High Fidelity Human Patient Simulator

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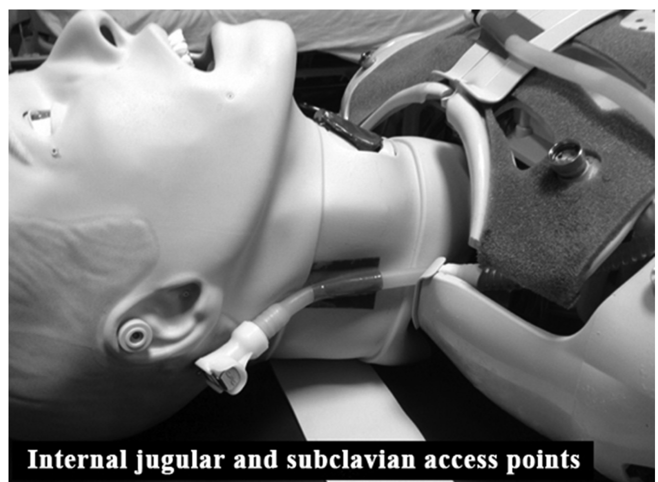
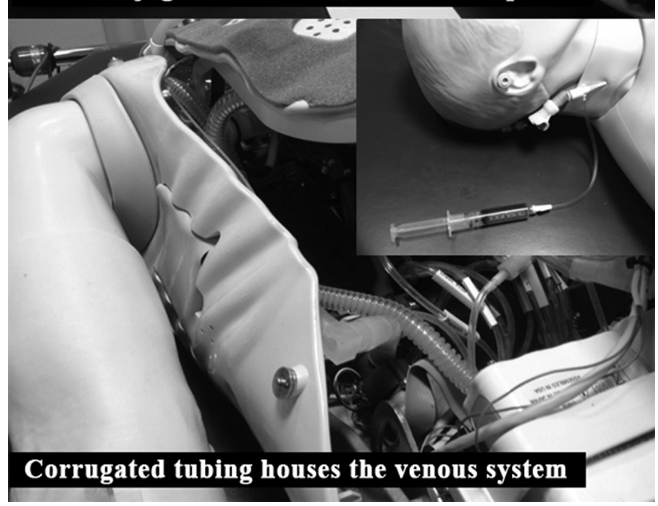
Introduction/Background: Temporary transvenous pacing (TVP) is a high risk, low frequency procedure for emergency medicine residents and nurses. This procedure is critical when needed but, due to the low frequency, residents sometimes complete their training without performing this skill on a live patient. This can cause a lack of skill and confidence when they need to use this skill as an attending emergency room physician. There is limited availability of commercial TVP task trainers and no commercially available high fidelity human patient simulator designed for TVP insertion. The gap between putting all the skills together in one seamless, scenario-based training experience continued to be a problem for EM residents. Increasing the residents' confidence and competence in this procedure, which is potentially lifesaving, may directly impact patient outcomes.

Description: We developed a modification to Laerdal's high fidelity human patient simulator (SimMan3G) by adding a self-contained basic venous system that allowed the learner to introduce a TVP into the SimMan3G. Learners are able to perform the TVP procedure as they would on a real patient. Learners are able to see a flash with the needle stick, are able to insert the introducer and float the pacer wire to the desired depth, all with the ECG changes expected during insertion. In order to simulate the venous system needed, we used tubing from several old used task trainers, filled it with simulated blood and housed it inside of an outer shell made from a section of corrugated tubing from our respiratory cart, to protect the interior electronics of SimMan3G. (See images. Inset photo shows sheath placed and ready for TVP placement, with blood return. Red blood used for photo only). We then used the Laerdal scenario programming feature to develop a scenario that the simulation





technician can activate when the pacer wire is introduced causing the patient to have the appropriate arrhythmias during TVP insertion. Only when the TVP catheter is placed in the correct location and depth and the appropriate voltage is set will the human patient simulator be switched to a paced rhythm, which in turn starts the desired clinical effect. The learner must verbally state the current depth of the pacer wire while inserting. A live video feed is also used. All materials used to create this were found in our supply room from expired and donated medical supplies resulting in little to no cost to our institution.

Conclusion: We have begun using this simulator modification in our emergency medicine residents' skills training. 17 learners have used this modification during simulation. All expressed positive remarks and stated they had increased confidence in their ability to perform this task. Since then we have had an overwhelming response from other EM residents of all OGME levels wanting to do this scenario. Since the start of this training we have used a competency checklist with three levels: beginner, novice and expert. We are collecting this data over the course of the academic year, as well as tracking how many TVP procedures the residents are able to do or be a part of. The data is still being processed as we are currently in the middle of the emergency medicine residents' quarterly skills evaluations. Additionally we are looking at using this program in critical care and nursing programs. By using the SimMan3G with the basic venous system modification we designed we are able to provide high fidelity TVP insertion training to our learners. This high fidelity training will lead to more experience of a low frequency, high-risk procedure, resulting in greater confidence and competence by our learners. All of this should have a positive and lasting effect on patient outcomes.

Disclosures: None

1734

Interactive Simulation Sessions for Veterinary Students Using Digital Videos

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Introduction/Background: Realism in healthcare training provides an experience that may enhance a learner's ability to retain and apply new information. Simulation provides a powerful educational tool to support didactic content in a hands-on, dynamic environment. One of our goals is to address challenges and applicability of using various approaches to simulation in basic sciences curriculum.

Description: During Spring 2012 term, faculty from the School of Veterinary Medicine (SVM) wanted their students to better understand the action of drugs and effects of drug interactions during a simulated animal surgery. In our university-wide multipurpose Sim Lab, cats, dogs, sheep and horses are physiologically simulated in high fidelity human manikins with only torso and IV access displayed. For each case scenario, the SVM faculty instructors drew a diagram describing a case patient undergoing anesthesia, along with a flow chart showing time in surgery and phases during the procedure where appropriate medication should be given. We worked closely with the faculty to develop a way to show options that might be chosen during a simulated surgical session in the Sim Lab. Electronic media provided a consistent way to assess knowledge and response. Students began the session with an anesthesiology case scenario that contained patient history and time on the surgery table. Time increments were presented in phases: usually baseline, then 30, then 60, and then 90 minutes into a surgical procedure. Students were able to see what would happen in a given situation, at a specific time point, and with a specific drug choice. They were given the option of 6 to 8 different drugs to push intravenously, then to see the outcome on a simulated 12 lead monitor showing common physiologic parameters that would be checked during a procedure. We used video client software to capture simulated output from a 12-lead monitor, made an AVI video file of each scenario baseline vitals for 3 time phases, then made AVI videos of each drug action for that phase. For each option, the results were saved as a video file that could be displayed to show what would happen as a result of that choice. The technique was piloted on 60 SVM students enrolled in an anesthesiology / pharmacology course who rotated through the Sim Lab, but this modality can be transferred to other settings. The technique proved easy to teach to technologically adept colleagues. The AVI file will play on any laptop or PC and can be integrated into PowerPoint slides along with an audience response system. Similar versions of this idea of capturing physiologic changes dynamically on a simulated 12 lead monitor can be a fairly quick addition to lectures with audiovisual support. An educator can then choose to show the most popular answer, the right answer or the most clearly wrong answer and watch the corresponding AVI video in any classroom setting.

Conclusion: We used electronic media during a simulation session to provide immediate feedback to students. This contributed to a dynamic and engaging opportunity to assess knowledge in a real situation. It allowed educators to apply simulation activities using video options to reinforce learning. Importantly, instructors were able to demonstrate how a surgical environment is arranged to monitor patient care within the safe learning environment of the Sim Lab. The video clips were well received by faculty and students. We demonstrated that creating AVI files from 12 lead monitor output was a very direct method to provide feedback during a simulation session. Since health care providers must learn to make multiple decisions over time, the opportunity to practice choosing the most appropriate next step is essential to develop both knowledge and confidence in decision-making skills.

Disclosures: None

1760

Creating an Interactive NeuroLogic Virtual Patient to Complement the Study of Spinal Cord Functions and Lesions

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Introduction/Background: For most students in the health professions, Neuroscience represents a fascinating area of study and at the same time a challenging discipline due its complexity. Although useful, 2D graphics and pictures in textbooks, atlases and plates are limited spatially and temporarily and often do not fully clarify concepts and relations, even when they are presented juxtaposed with real specimens, 3D inanimate models, CT and MRI. These difficulties become even more evident when the students are asked to apply the learned concepts to clinical situations (e.g. lesions). As a result, instructional methodologies and technologies that complement the more traditional classroom or lab setting are sought after to enhance the learning experience, encourage the students' participation as active learners, add context, and provide increased consistency in the instructional process.

Description: An interactive 3D virtual patient appears as an ideal solution to aid in the teaching and learning of neuroscience. With these goals in mind, we planned and started building a virtual patient by collecting many disparate but richly interconnected elements offered by the interview and physical examination of the nervous system in a single interface. The ultimate aim has been to create a navigable model that allows the instructor and learner to explore the neuroanatomy, correlate it with functions and apply the knowledge to lesions and deficits. In its initial stage, the project has served as a limited proof-of-concept and was focused on certain structural and functional characteristics of the spinal cord and on a selected number and types of lesions. However, the project was designed in a way that gives the students two options as the starting point: 1). examining a patient with an unknown lesion of the spinal cord or 2). knowing where the lesion is and demonstrating or reviewing their knowledge regarding the most likely clinical manifestations associated with it. In both cases, the students have the possibility to perform a simplified neurological examination by selecting tools and parts of the body to be tested. 3D models of the patient as well as the possibility to view relevant internal anatomical details were constructed and animated in the open source 3D program Blender. These assets were then scripted for interactivity in the Unity game engine. Through Unity, the neuroscience applications were published to Windows and Mac operating systems in addition to a website, allowing access to both students and the instructor. Ultimately, adding the time-factor (4D) may appear as a too ambitious project. However, it does increase the relevance of the case studies and the usefulness of the learning exercise.

Conclusion: The Net or Millennial generation has grown up with technology, is comfortable with it, and expects it to become involved in their everyday life. This increasingly applies to their education. While most students don't outright prefer interactive modules, nearly all find them to be more engaging, enjoyable, and complementary to their learning styles. Many offer both graphics and text for visual and verbal learners but the most crucial element is self-paced, active learning. The students are able to slow down when they don't fully understand and go faster when they do. This is especially important as lecture material becomes denser with continued research. Our neuroscience module, *NeuroLogic: Interactive Spinal Cord Lesions*, has been successfully produced for multiple, easily accessible platforms and will be integrated as a pilot experiment in the Neuroscience pre-matriculation course and later in other courses and programs. After this step, the efficacy of the project will be better evaluated with comparisons between the testing class and previous years and a survey to determine audience enjoyment, engagement, and perceived instructional value.

Disclosures: None