VIRTUAL MEETING

MARCH 10, 2021

A Dialogue

surg-eng

PROGRAM BOOK

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On behalf of the Program Committee and the Division of Education, welcome to the Annual 2021 Virtual American College of Surgeons (ACS) Surgeons and Engineers: A Dialogue on Surgical Simulation. In 2019, we received an overwhelming number of requests to expand this meeting, and we, therefore, hope you are as excited as we are to participate in a full day of activity!

With these goals in mind, the program committee has planned a premiere program to foster dialogue, enhance knowledge, build relationships, and spark ingenuity:

- Keynote Address—Medical Robotics and Computer-Assisted Surgery: Our keynote speaker, Russ Taylor, PhD, is a renowned authority on this subject with more than 40 years of professional experience in computer science, robotics, and computer-integrated interventional medicine.
- Special Panel Discussion—Successful Collaboration between Surgeons and Engineers: A special panel of surgeons and engineers, specifically chosen for their highly regarded expertise and experiences in surgeon-engineer partnerships, will share their knowledge and experience on this important topic.
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All sessions will be held virtually for the meeting registrants in Central Time. The schedule is subject to change.

9:00–9:10 am	Welcoming Remarks **Ajit K. Sachdeva, MD, FACS, FRCSC, FSACME, MAMSE,** Director, American College of Surgeons Division of Edu **Gyusung Lee, PhD,** Program Co-Chair and Assistant Director, Simulation-Based Surgical Education and Training American College of Surgeons Division of Education **Mandayam Srinivasan, PhD,** Program Co-Chair and Founder, Laboratory for Human and Machine Haptics, Massachusetts Institute of Technology; Professor of Haptics, Computer Science Department, University College, London, UK
9:10–9:55 am	CsseoS Q9 S Qhoe oA4 (edd)1131 (egs4 (e)]TJ 0)]j 0T1_231 Tf 00 0 0 10 122.8 65548253 Tm [(Medc)

Program Chairs

Gyusung I. Lee, PhD

Mandayam A. Srinivasan, PhD

Founder, Laboratory for Human and Machine Haptics, Massachusetts Institute of Technology;
Professor of Haptics, Computer Science Department, University College, London, UK

Prof. Mandayam A. Srinivasan is the founder of the Laboratory for Human and

Keynote Speaker

Russell H. Taylor, PhD

John C. Malone Professor of Computer Science with Joint Appointments in Mechanical Engineering, Radiology, and Surgery; Director, Laboratory for Computational Sensing and Robotics, Johns Hopkins University

Russell H. Taylor received his PhD in computer science from Stanford in 1976. After spending 1976 to 1995 as a research staff member and research manager at IBM Research, he moved to Johns Hopkins University, where he is the John C. Malone Professor of Computer Science with joint appointments in mechanical engineering, radiology, and surgery and is also director of the Laboratory for Computational Sensing and Robotics (LCSR) and of the (graduated) NSF Engineering Research Center for Computer-Integrated Surgical Systems and Technology (CISST ERC). His research interests include medical robotics and computer-integrated interventional medicine. Dr. Taylor is a Fellow of the IEEE, the AIMBE, the MICCAI Society, the National Academy of Inventors, and the Engineering School of the University of Tokyo. He has received numerous awards, including the Maurice Mueller Award, the IEEE Robotics Pioneer Award, the IEEE EMBS Technical Field Award, and the Honda Prize. Dr. Taylor's research interests include all aspects of computer-integrated interventional medicine, with a special interest in surgical robotics, medical image analysis, and human-machine cooperation in the operating room.

Erik P. Dutson, MD, FACS

Clinical Professor of Surgery, UCLA; Chief, UCLA Section of Minimally Invasive and Bariatric Surgery; Executive Director, Center for Advanced Surgical and Interventional Technology (CASIT), University of California, Los Angeles

Dr. Erik Dutson is a professor of surgery at UCLA and is the chief of minimally invasive and bariatric surgery. Dr. Dutson is currently the executive

Panelists Continued

Silvana Perretta, MD

Professor of Surgery, University Hospital (NHC), Strasbourg, France; Chief, Foregut and Advanced Gastrointestinal Endoscopy Division; Director of Education, IHU-Strasbourg, France; Vice-President IRCAD, Research Institute Against Digestive Cancers, Strasbourg, France

Robert Sweet, MD, FACS

Executive Director of WISH, WWAMI Institute for Simulation in Healthcare; Medical Director, UW Medicine Kidney Stone Center; Professor, Department of Urology, University of Washington

Dr. Silvana Perretta is an upper gastro-intestinal surgeon, chief of foregut and advanced gastrointestinal endoscopy division. Dr. Perretta has served as director of IHU Education and of the surgical endoscopy fellowship program since 2014. Since 2011, Dr. Perretta has run the Business Engineering and Surgical Technologies (B.E.S.T) education program, a custom-designed health care innovation program. Her fields of interest include upper gastro-intestinal surgery, gastro-intestinal physiology, bariatric surgery, interventional endoscopy, surgical education, and innovation. Dr. Perretta has been a pioneer in the development of Natural Orifice Transluminal Endoscopic Surgery (NOTES), hybrid surgical endoscopy procedures, endoscopic platforms, flexible robotics, image-guided therapies, endoscopic simulators, and MOOC-oriented medical education worldwide.

In 2011, Dr. Perretta was awarded the SAGES career development award. Dr. Perretta recently received a €1.2 million government research grant for the development of e-learning and education in the field of surgical endoscopy, image-guided therapy, and med-tech innovation, and a €140 thousand grant from the University of Strasbourg's Institute for Advanced Studies to develop hybrid materials for fighting obesity. She has been the vice-president of IRCAD France since June 2019.

Dr. Sweet is a professor of urology, surgery, and bioengineering at the University of Washington and the founding medical director of the UW Medicine Kidney Stone Center. Dr. Sweet founded and led the University of Minnesota's SimPORTAL and cofounded the University of Washington's ISIS, which was renamed the University of Washington, Wyoming, Alaska, Montana, and Idaho Institute for Simulation Technologies (WISH) when he assumed the executive director position. He is the Principal Investigator (PI) for all programs in the Center for Research in Education and Simulation Technologies (CREST), including the "Advanced Modular Manikin" project. CREST programs have been funded by the Department of Defense, NIH, and industry and have led to the development elopforIhave l4 fsumed the 8(or (PI) rchnologies)ent o 0 (elohealth

🟧 Abstract Code 🟦 Abstract Category

O-1 Research In-Progress

Machine Learning and Mixed Reality Surgical Simulator for Autonomous Instructional Guidance and Performance Assessment

Nihar N. Sheth, MS, Mechanical Engineering; Nicholas Marjanovic, BS, Bioengineering; Nishant Srinivasan, MBBS, MD, Pediatrics, Neonatal-Perinatal Medicine; Cristian J. Luciano, PhD, MS; and Saurabhkumar C. Patel, MD, MPH, Pediatrics and Neonatal-Perinatal Medicine
University of Illinois at Chicago, Chicago, IL

Introduction: Interactive instructional feedback and performance assessment of learners during surgical simulation and training are effective to increase patient safety, but they are long, subjective, difficult, expensive, and instructor-heavy tasks. The goal of this project is to develop a fully autonomous training system that will be able to provide precise, accurate, and real-time instructional coaching, as well as objectively measure learners' skill performance using a combination of machine learning (ML) and mixed reality (MR) technologies. As a proof of concept, the simulator will be applied for teaching neonate thoracentesis and pericardiocentesis, which are rare but complex life-threatening procedures.

Methods: Based on MRI and CT scans of real patients, a virtual 3D anatomical model has been designed and used to create a manikin using 3D printing technology. The flexible organs (pleura, collapsed lung, and heart) and rigid bony structures (ribcage and spine), have been encased in flexible silicone to simulate the skin and underlying soft tissue. A software application is currently being developed for combing real and virtual 3D patient anatomy and surgical instruments in a mixed reality environment. Trainees' actions during surgical training are determined by tracking and storing the 3D positions and orientations of multiple surgical instruments with an NDI DriveBay electromagnetic system.

Preliminary Results: The flexible 3D printed organs allow for realistic ultrasound-assisted needle insertion. A preliminary evaluation and content validation about anatomical details, realism of ultrasound guidance, and tactile feedback have been provided by Pediatrics surgeons, experts in performing and teaching these surgical procedures.

Next Steps: The captured tracking motion data will be used to train a recursive neural network to detect and classify the execution of the different surgical steps being performed by experts and novices during the simulated surgical procedures, and in-turn provide relevant instructional guidance and valuable feedback about the trainees' surgical skills.

3D-printed model of flexible lungs and pleura and rigid ribcage.

Flexible silicone enclosing the 3D-printed neonate anatomy.

O-2 Research

Open Source Platform for Automated Collection and Interpretation of Training Data in Open Surgery

Jacob R. Laframboise; Tamas Ungi, MD, PhD; Kyle Sunderland, MSc; Gabor T. Fichtinger, PhD; and Boris Zevin, MD, PhD, FACS
Laboratory for Percutaneous Surgery, Queen's University, Kingston, ON; Department of Surgery, Queen's University, Kingston, ON

Introduction: Automatic detection of workflow steps in surgery could improve surgical training. Additionally, automatic surgical video annotation could generate useful surgical training material. A platform to collect and organize tracked video data would enable rapid development of deep learning solutions for surgical video annotation in open surgery. The purpose of this research was to demonstrate surgical video annotation on the 3D Slicer / PLUS Toolkit platform by classifying and annotating tissue-tool interactions in simulated open inguinal hernia repair.

Methods: PLUS Toolkit collected tracking data from an optical tracker and video data from a camera, which were saved in 3D Slicer. To demonstrate the platform, we identified tissues being interacted with in surgical video using a neural network and identified the tool in use with the tracking data. A custom Slicer module was used to deploy this model for real-time annotation.

Results: This platform allowed the collection and organization of over 120,000 labelled tracked video frames for training a convolutional neural network (CNN) to detect tool interactions with tissues. The CNN was trained on this data and applied to new data with a testing accuracy of 86%. The model's predictions can be weighted over several frames with a custom Slicer module to improve accuracy.

Conclusions: Our proof of concept model successfully identified tissues with a trained CNN in real time (30fps), while optical tracking data identified the tool. The 3D Slicer and PLUS Toolkit platform is a viable platform for rapidly collecting a large volume of training data in short time. The platform allows deployment of a solution utilizing optical tracking and video processing for real-time annotation (Figure). This motivates further use of 3D Slicer / PLUS in video annotation and training in open surgery.

O-3 Promoting Technology and Collaboration

Retropubic Trocar Modified with a Load Cell to Measure Force

Gary Sutkin, MD; Gregory W. King, PhD; and Antonis P. Stylianou, PhD
University of Missouri, Kansas City, Kansas City, MO

Background: The Midurethral Sling surgery involves blind passage of a sharp steel trocar within millimeters of the urethra and bladder, and 2-5 centimeters from the bowel and iliac and obturator vessels: injuries are well documented. Safe procedures involve maintaining constant trocar contact with the suprapubic bone, which can be difficult for a teaching surgeon to assess when a resident performs.

Technology Overview: This force-sensing trocar was developed through collaboration between a pelvic surgeon and two biomedical engineers. We modified a retropubic TVT trocar (Ethicon, 810041BL) with a load cell (Futek LCM200) retaining the original dimensions and recording unidirectional force exerted on its handle.

Potential Application in Surgical Simulation and Education: Two pelvic surgeons performed bilateral retropubic passage of the force-sensing trocar on a thiel-embalmed cadaver and a physical model on two different occasions. The physical model was created by segmenting a Midurethral Sling candidate's MRI, 3D-printing, and filling with thermoballistic gel. Cross-correlation analyses on time- and amplitude-normalized force time histories revealed high correlations between model forces measured on different occasions; and between model and cadaver forces. Paired t-tests on maximal amplitude (F_{max}) and root-mean-squared amplitude (F_{rms}) from force time histories revealed no significant differences between model trials on different occasions (F_{max}: p=0.786 and p=0.253 for right and left passages, respectively; F_{rms}: p=0.327 and p=.277 for right and left passages, respectively); and few significant differences between model and cadaver trials (F_{max}: p=0.036 and p=0.286 for right and left passages, respectively; F_{rms}: p=0.053 and p=.101 for right and left passages, respectively). This suggests high test-retest reliability of the model/trocar system, and adequate biofidelity of the simulation model.

Potential Opportunities to Collaborate: In our next collaboration, this novel force-sensing trocar will be used to test the role of force in injury to vital organs. Expert surgeons and PGY1-4 residents will perform retropubic trocar passage on the simulation model using the force-sensing trocar. Unidirectional force will be supplemented with motion capture data, recording contact between the tip of the trocar and bone.

O-4 Research In-Progress

The Development and Validation of a Novel High-Fidelity Simulator for Parotid and Facial Nerve Surgery

Fanny Gabrysz-Forget, MD, and Bharat Bhushan Yarlagadda, MD, FACS
Lahey Hospital and Medical Center, Burlington, MA

Introduction: Parotid surgery is challenging to learn and teach due to potentially morbid complications such as facial nerve injury. We present the development of a novel low-cost high-fidelity model for training of parotidectomy with pilot data of prospective validation studies.

Methods: The model consists of a 3D-printed skeletal and multiple silicone-based soft tissue portions of various densities to replicate skin, parotid, and tumor. Copper wire replicates the facial nerve and is circuited to indicate contact with instruments. Face validity is evaluated using a 21-item 5-point Likert scale QR. Participant performance was likewise evaluated. Content validity was determined by comparing expert and novice performance, and via a survey completed by the trainees after their immediate subsequent live parotidectomy following simulation.

Preliminary Results: Twelve residents and six faculty completed the simulated procedure of superficial parotidectomy after watching a video demonstration. Over the 16 steps of the surgery evaluated by this simulator, the mean assessment score for faculty was 15.83 ±0.41 compared to 13.33±2.06 for residents (p=0.0081). The ability to distinguish groups indicates high content validity. Overall, the value of the simulator as a training tool was well received by both faculty and residents (5 vs 4, p=0.0206), however faculty were more likely to respond positively with regards to overall realism (4.5 vs. 3.5, p = 0.0155), and tumor realism (5 vs 4, p = 0.0264). Low scores were received particularly regarding skin realism.

Next Steps: This low-cost soft-tissue surgical trainer for parotidectomy and facial nerve dissection has showed face and content validity and will contribute the surgical education of early stage trainees. As low feedback was received regarding skin tissue realism and quality, future directives are intended to improve the soft tissue quality via alteration of the silicone materials used. In addition, sensors can be used in the circuit to indicate duration and intensity of facial nerve contact, rather than the current binary feedback. Similar models can be applied to additional anatomies, such as thyroid surgery.

O-5 Research

Non-Inferiority Assessment of a Self-Study; Self-Debriefing Mixed Reality Simulator for Central Venous Access

Samsun Lampotang, PhD, FSSH; George Sarosi, MD; Edward McGough, MD; Nikolaus Gravenstein, MD; Lou Ann Cooper, PhD; David Lizdas, BS; Anthony DeStephens, MSME; Andrew Gifford, BS; Desmond Zeng, MS; and Josh Sappenfield, MD
University of Florida, Gainesville, FL

Introduction: Simulators are more often idle than not. We developed a simulator with an optional integrated tutor (IT) for self-study/self-debriefing when instructors are unavailable. We hypothesize that our IT has similar, rather than superior, effects, i.e., can be non-inferior to an Anesthesiology human instructor (HUM) in helping trainees acquire procedural skills on a simulator.

Methods: We conducted a power analysis/sample size calculation for a non-inferiority analysis on the difference in two independent proportions, assuming =0.05, power=0.80, a high success rate expected for both groups (95%) [illegible]

O-6 Research

Segment-Level Assessment of Surgical Technical Skill Using Machine Learning for Automated Surgical Coaching and Deliberate Practice

Anand Malpani, PhD; S. Swaroop Vedula, MBBS, PhD; Chi Chiung Grace Chen, MD, MHS; and Gregory D. Hager, PhD
Johns Hopkins University, Baltimore, MD

Introduction: Technical skills coaching is important for improving patient outcomes in surgery. However, expert one-on-one coaching is not scalable for routine assessment and feedback. Our work is toward augmenting a human surgical coach with an automated virtual coach. Routine and targeted assessment is needed to enable deliberate practice which leads to efficient and effective learning. In this work, we present an approach that can generate ranking scores for a given performance at segment-level.

Methods: We used a dataset of 30 performances of the “Suture Sponge I” task available on the da Vinci Skills Simulator, a virtual reality simulation training platform for the da Vinci system. This dataset contained video, instrument motion, and endoscope motion recordings. We labeled start and end of each constituent needle passing segment resulting in 360 such segments. We obtained pairwise comparisons-based skill ratings for 100 pairs of performances generated by random selection of segments. This involved a rater to view a pair of performances side-by-side on a web page and select their “preference” indicating the better skilled performance. The rater indicated their level of confidence in choosing the preference on a 3-choice question. We recruited 5 raters per pair and chose the majority rating as the preference for the pair. We computed 7 metrics using motion data, e.g., completion time, instrument path length, instrument shaft area swept, and instrument velocity peaks. We used the “support vector machine” algorithm, a machine learning technique, to predict preferences by using the metrics for the given pair of performances. We performed 5-fold cross validation to estimate the accuracy of the algorithm.

Conclusions: LapTool-Net can be used in real-time for monitoring surgical actions to prevent errors and provide instantaneous feedback for quality improvement. It can also be used offline for the assessment of the recorded videos, information retrieval for education purposes and operative summary report generation.

O-8 Research In-Progress

Interprofessional Discovery Learning of the Human Biomedical Musculoskeletal System: Combining a Virtual Patient Case [illegible]

Methods: A comprehensive literature review was performed

SAVE THE DATE

March 2, 2022

SURGEONS AND ENGINEERS:

A Dialogue on Surgical Simulation

Wednesday, March 2, 2022
Swissôtel, Chicago, IL

FOR FUTURE UPDATES, PLEASE VISIT

facs.org/surg-eng

A Call for Abstracts will be announced in late summer 2021.

P-01 Research

Novel Application of Reinforcement Learning to Automate Surgical Subtasks Rendered in a Virtual Soft-Body Simulation

Alexandra Tan Bourdillon, BS; Animesh Garg, PhD; Hanjay Wang, MD; Joseph Woo, MD; Marco Pavone, PhD; and Jack H. Boyd, MD
Yale School of Medicine, New Haven, CT; University of Toronto, Toronto, ON; Stanford School of Medicine, Stanford, CA

Introduction: The revolutions in artificial intelligence hold tremendous capacity to augment human achievements in surgery, but robust integration of deep learning algorithms with high-fidelity surgical simulation remains a challenge. We present, to

The SMMARTS SDK (https://github.com/UF-CSSALT/SMARTS-SDK) developed in Unity Technologies' Unity game engine consists of features to facilitate the development of medical simulators. SMMARTS includes an Arduino microcontroller and Ascension Technology Corporation's 6DOF tracking connectivity along with software tools like a replayer feature, user interface templates, 3D model visualization, scoring monitors, cognitive aids, common error messages, and Experience API LMS compatibility.

Potential Application in Surgical Simulation and Education: The SMMARTS platform has been used to develop simulators in our lab (ventriculostomy-EVD, epidural loss-of-resistance, instructor-less central venous access, TRUS prostate biopsy, pterygopalatine fossa block, lumbar/chronic pain blocks, intravenous access, and chest tube insertion) and externally (hardware front-end to practice psychomotor skills for a third-party screen-based simulator). A potential application is US-guided hip effusion biopsy for orthopaedic surgery and other fluid and tissue biopsies. SMMARTS can currently track a Kelly clamp and can be extended to track other surgical instruments.

Potential Opportunities to Collaborate: As an open architecture platform that has been used to develop multiple compact, deployable, turnkey simulators including one currently deployed in Iraq, SMMARTS is available for use by third parties to rapidly develop simulators for new procedures including surgical ones and also extend SMMARTS platform capabilities.

P-03

Next Steps: The next step is to validate the simulator and develop a curriculum that will give access to trainees to evaluate and treat a simulated patient using the ECMO simulator. This will include cannulation, initiation and management of a simulated patient.

P-04 Research In-Progress

Kinematic and Kinetic Task Performance Data for Holistic Assessment of Skill at Robot-Assisted Minimally Invasive Surgery

Sergio Machaca; Rachel M. Haupt; Anand Malpani; and Jeremy D. Brown
Johns Hopkins University, Baltimore, MD; University of South Carolina, Columbia, SC; Johns Hopkins University, Baltimore, MD

Introduction: As robot-assisted minimally invasive surgery (RAMIS) becomes the standard of care for many surgical specialties, there is a growing need to ensure that all robotic surgeons have the same fundamental level of skill proficiency. Current clinical training and assessment, in particular with the real clinical robot, focus more on reducing the observable egregious errors like breaking a suture or tearing tissue, and less on the underlying psychomotor behaviors that lead to these egregious errors. Recent skill assessment efforts have separately focused on the motion of the surgical tools (kinematics) or their physical interactions with the surgical environment (kinetics). The ideal skill assessment platform, however, should consider the interplay between the two, given their interdependence in psychomotor skill proficiency

Methods: We have developed a data acquisition platform that is capable of measuring time-stamped kinematic and kinetic task performance data from a da Vinci surgical system, as well as the video feed from the robotic endoscope. Joint-h (y on)18La9kinemaMinimally In, sn perf-04 medical procedures and actions, and interpreting and assessing the results of an individual and team learners progress through a collection of scenarios. SNOMED-CT has a nomenclature, and a system of terms already spanning a large area of medicine that is both human and computer readable, it is well suited to serve as a lingua franca for information exchange between computers during a simulation and also supporting solving other challenges that occur when addressing understanding complex medical training.

Potential Application in Surgical Simulation and Education:
We are using SNOMED-CT an international open standard, as a basic language for the Medical Simulation Training Architecture, MSTA, for the U.S. Army and will use this to link their medical simulation centers to the Department of Defense's Synthetic Training Environment and to civilian training systems. A brief characterization of SNOMED-CT and its application into these domains will be given.

Potential Opportunities to Collaborate: Simulation software companies.

P-06 Challenges in Surgical Education

Bridging the AI Chasm in Surgical Simulation: Are Surgeons and Engineers Sufficient?

S. Swaroop Vedula, Mathias Unberath, Anand Malpani, Brian Caffo, and Gregory Hager
Johns Hopkins University, Baltimore, MD

Background: Machine learning and Artificial Intelligence (ML & AI) methods are critical for advances leading to next generation surgical simulation.

Current Challenges: Despite the enormous potential ML & AI methods hold for technology-enhanced surgical education, one major challenge limits its advance—the critical need to educate surgeons and engineers with cross-disciplinary concepts to enable effective collaborative research. Specifically, surgeons must understand fundamentals of data science for AI in surgical education. On the other hand, engineers must understand how technology to enhance surgical education are evaluated; this includes study design, bias, validation methods, and how

Next Steps: The custom-built software needs to be externally validated by others to confirm content validity and incorporated augmented reality for improved simulation environments, and development of large databases with training and performance data that enable clinical performance to inform needs for simulator training and vice versa. Additional ideas explored the need for better methods of detecting high individual workload and interventions to monitor and improve trainees' non-technical skills. Identification of such needs for technological intervention can help set research agendas for integrated surgical and engineering research projects in the future.

Introduction: Recorded videos from laparoscopic procedures contain valuable information, which can be extremely useful in surgical education and training. To efficiently utilize these videos, important features such as the usage of surgical tools and different phases need to be extracted, which can be cumbersome to do manually and hence an automated system needs to be developed.

Methods: With the advent of deep learning, such tasks can be accomplished by training deep convolutional and recurrent neural networks (CNNs and RNNs) to learn the spatial and temporal visual features. We designed two Recurrent Convolutional Neural Networks (RCNNs) to identify the appearance of different surgical tool combinations and, the current phase of each frame of a laparoscopic video using the knowledge of five previous frames.

Preliminary Results: We tested our models on a dataset that contains 80 videos from laparoscopic cholecystectomy. We obtained frame-level accuracy of 79.97% for tool presence detection and 85.2% for surgical phase identification by separately training the RCNNs and further improved the performance by training RNNs at the post-processing step to 91.91% and 92.5% respectively.

Next Steps: [illegible]

P-12 Promoting Technology and Collaboration

From Scans and Model Collections to Interactive Surgical Simulation

Jorg Peters, Jennifer Cremer, and Ruiliang Gao

P-18 Research

Background: Percutaneous transhepatic biliary drainage (PTBD) is performed when there is an obstruction causing a buildup of bile in the common bile duct. This build up is often fatal if not addressed. PTBD is performed by using ultrasound (US) to guide the insertion of a Chiba needle percutaneously and into the bile duct. Using the Seldinger´s technique, a guidewire is then inserted through the stenosis into the duodenum, when feasible; otherwise, is left proximal to the stricture. A catheter or stent is then placed to promote drainage.

Current Challenges: Consistently and accurately placing the Chiba needle in the bile duct is difficult. This is a skill that must be practiced repeatedly and currently the only way to practice is on patients. Existing liver models are either able to be punctured and not ultrasound-able or ultrasound-able, but lack in training needle insertion. Many also do not have internal structures imitating the bile duct and the portal vein making it difficult to properly practice performing the procedure.

Need of Innovation Introduction: The ideal model meets five needs. The model should be anatomically accurate, with high fidelity biliary system. The internal anatomy should be visible under ultrasound and the vessels should be identifiable under Doppler supporting the inclusion of fluids. The model should simulate a biliary stenosis. The model materials should exhibit similar mechanical properties as human tissue. Finally, the model should be economical, supporting multiple uses and/or inexpensive production.

P-21 Research In-Progress

False Negative Proportions Increase with Template Deviation During Simulated, Systematic, Side-Fire Prostate Biopsy

Samsun Lampotang, PhD, FSSH; Patrick Shenot, MD, FACS; Jason Lee, MD, MHPE, FRCSC; Louis Moy, MD; Jonathan Wakim, BS; Yichao Yu, PhD; David Lizdas, BS; Nathan Perlis, MD, MSc, FRCSC; and Thomas Stringer, MD
University of Florida, Gainesville, FL; Thomas Jefferson University, Philadelphia, PA; University of Toronto, Toronto, ON; University of Florida, Gainesville, FL; University of UPenn, Philadelphia, PA; University of Florida, Gainesville, FL

Introduction: During freehand systematic prostate biopsy (sPBx), it is difficult to distribute the cores according to sPBx templates. We call the average of the shortest distance between each core center and its intended template location “template deviation”, a metric of how closely core centers match the template. sPBx false negatives (FN) range from 21–47% in patients. We investigated in a new simulator if sPBx template deviation is related to FN proportion.

Methods: Center B (n=12) and C (n=16) trainees performed simulated 12-core, double-sextant, side-fire, transrectal ultrasound (TRUS) sPBx. Baseline set Bl is before training; Tn after ~30 minutes training; Mt best score with continued training with a methodical technique. We placed virtual 4.9 mm radius spherical lesions, invisible with TRUS, at the right and left medial apex of a simulated 24.4 ml prostate. Unless a core and a lesion intersect, however slightly, a FN occurs. We calculated FN proportion (# of false negatives/# of sPBx 12-core sets) for each center at conditions Bl, Tn and Mt.

Preliminary Results: For both lesions, template deviation and FN proportion in both centers are related (p = 0.0015). The fitted model: Odds of false negatives = exp(-2.84 + 0.22 x TemplateDeviation) On average, the odds of FN increases by 25% (95%CI: 8.9–43.4%) with each 1 mm increase in template deviation, not differing significantly between centers or lesions. All 12 center B trainees completed competency-based training (competency = template deviation)5mm). Only 12/16 C trainees came back for further training to reach competency ( ) 5 mm), explaining the C Mt deviation >5mm.

Next Steps: We will explore further the relationship between template deviation and FN proportions for other lesion locations, shapes and sizes, different prostate shapes and sizes for side-fire, end-fire and transperineal sPBx. We have applied for research funds to translate our findings to reduction of sPBx FN in patients.

P-22 Research In-Progress

Evaluation of Two Performance Assessment Modalities for a Novel Pediatric Cleft Lip Repair Simulator

Saumya Gupta, BSE; Tatum Y. Zurawski, BS; Chelsea L. Reighard, MD, MSEd; Lauren A. Bohm, MD; David A. Zopf, MD, MS; and Deborah M. Rooney, PhD, MAMS
University of Michigan, Ann Arbor, MI

Introduction: With limited availability of pediatric surgical training models, trainees' exposure to pediatric procedures in otolaryngology and oral-maxillofacial surgery (OMFS) is limited to experiences in the operating room on patients. Traditional surgical teaching methods are not sufficient learning modalities for advanced procedures such as cleft lip repair (CLR). Using computer aided design and three-dimensional printing technology, pediatric CLR surgical simulators were designed and created along with web-based curriculum and assessment tools. Our earlier research demonstrated that the simulator improved trainees' performance. Continuing this work, we evaluated 2 procedural skills assessment modalities: a procedural video, and final photos of the completed CLR on the simulator for 5 trainees.

Methods: The course materials consist of a pre-module self-efficacy question (rated on 4-point scale) and 10-item multiple choice quiz, journal readings, video demonstration of the procedure, a post-module efficacy question and an online quiz. Five trainees submitted their performance video, and post-procedural photos of 3 different angles of the completed CLR. Performances and photos were rated by 2 otolaryngology and 2 OMFS faculty. Assessment tools consisted of 6 items on a 3-point scale and 1 global item, 'overall closure quality" (5-point scale). Mean ratings, inter-rater reliability, and practical aspects across modalities will be compared.

Preliminary Results: Learner self-efficacy ($p < 0.02$) and knowledge ($p > .05$) improved following training. Review of procedural videos and post-procedural photographs suggested training succeeds in increasing performance. Statistical comparison of rating differences and inter-rater agreement across assessment modalities will be reported in detail at the conference, and rater time commitment discussed.

Next Steps: The next steps are to further research the quality, cost, and benefits of both video and photo assessment methods. Future work will also expand this research to larger and more varied cohort of trainees and raters to evaluate the generalizability of these preliminary findings.

P-23 Research In-Progress

Building Blocks toward a Laparotomy Trainer

David M. Hananel, BSEE, BACS; Jason Speich; and Robert M. Sweet, MD, FACS
University of Washington, Seattle, WA

Introduction: Designing and building a laparotomy trainer that allows a surgical team to practice as a team, challenge all participants and provide meaningful feedback is a daunting task: it needs to bring together technical, decision making and team performance skills together in a unified platform. The Center for Research in Education and Simulation Technologies (CREST), under contract #W81XWH-14-C-0101 has developed a "Distributed, Modular, Interoperable" platform for health care simulation, called the Advanced Modular Manikin that supports all of these facets.

Methods: By working toward a System of Systems, following some basic design rules, we created a platform that allows for an almost open-ended expansion and supports collaboration between many developers and researchers: Key data traffic based on clinically relevant data. The "manikin" is a display for the state of the patient, regardless of instantiation: physical, virtual, or hybrid. Local issues are resolved locally, events that cause a systemic response are communicated to the core. Core does not know the inner workings of modules. Modules are not aware of each other, but of patient.

Preliminary Results: The various building blocks that connect to the AMM platform made it possible to create a Laparotomy trainer that brings together technical, decision making and team performance skills. The Laparotomy insert allows team members to collaborate on technical skills. The various cues provided on the ventilator, patient monitor, as well as, controlled bleeding in the abdominal cavity elicits ongoing decision making and finally the interplay between patient management by the anesthesiologist and progress of the surgery via the physiology engine requires team interactions on an ongoing basis. All required modules have been built and the system will be evaluated in the field.

Background: Surgeons need to continuously learn and improve; review, assessment and revalidation of performance is critical. Currently, this is relatively cumbersome and there is little standardization across specialties and health care providers.

Current Challenges: Surgeons are unable to track their performance over time, which makes standardization of surgery and sharing of best practices challenging. Surgical record keeping is inadequate and there is a lack of secure and usable storage solutions. There is no clear standpoint in health care for digital data acquisition and utility. Trainees have restricted hands-on operating time, and there are limited technological solutions that they can use to rehearse and assess ahead of ‘real-time’ operating. There are no standard solutions to track trainees’ performance and progress over time, making it difficult to evaluate performance quantitatively.

Need of Innovation Introduction: Novel technology is required to enable the sharing of best practices, monitoring and performance review. We built TouchSurgery Professional (TSPro), on top of the globally recognized and validated simulation-based training platform, Touch Surgery. TSPro, a web platform for surgical video data storage, ann (g,a-42Td (w)3 s00.9 (e(orr)18 (actic)9 (es, monTd (,]TJ de 3Tgn (o enable)18o, ann23D
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Please contact Gyusung Lee, PhD
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EXHIBITORS

Meeting participants have asked for exhibitor involvement.
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