EXECUTIVE OVERVIEW

• ASTEC was selected to present a video showcase depicting the innovative ASTEC continues to be a leader in the delivery of high-fidelity medical simulation.

• As a national leader in the development of artificial tissue, ASTEC has devised new methods for creating more realistic models, some of which incorporate the use of 3D modeling technologies.

• ASTEC has entered its 7th year of developing the Computer-Assisted Surgical Trainer (CAST) system, introducing a portable version along with a computer tablet application that allows users to train independently but with instrument motion analysis and progress mapping still provided.

• ASTEC remains #1 in product utilization for Karl Storz Endoscopy-America instrumentation to help carry out the education and research mission of the Arizona Health Sciences Center.

• As a national leader in the development of artificial tissue, ASTEC has devised new methods for creating more realistic models, some of which incorporate the use of 3D modeling technologies.

• ASTEC continues to be a leader in the delivery of high-fidelity medical simulation, conducting 16 upgrades in equipment and facilities to provide higher-quality simulation encounters with greater efficiency and adapting environments to multidisciplinary objectives.

• ASTEC was selected to present a video showcase depicting the innovative design of our simulation center at the AAMC Annual Meeting, held in San Francisco in November, 2012.

From the Executive Director

This has been an iconic year for ASTEC; the University of Arizona College of Medicine and Health Sciences Center has now been nationally accredited as a simulation center by the Society for Simulation in Healthcare (SSIH). SSIH certification now permits us to reach beyond individual medical and health care subspecialties to a much broader, far-reaching simulation mission.

We are extremely proud that ASTEC now becomes one of only 32 centers in the United States with such certification and joins other worldly simulation institutions such as Yale, University of Pittsburgh and Children’s Hospital of Philadelphia. It is a testament to the gifted faculty, nurses, and staff that ASTEC can maintain the highest national standard of excellence in simulation education.

The world of medical simulation is never boring. Right now, it is the fastest-moving, quickest-shiftin field of education because it is being heated up by the emergence of new digital and learning technologies. But it is also being pressure-cooked, at the same time, by our society’s need for increasingly cost-effective, error-free health care. Welcome to the perfect storm. Yes, it is tempestuous, but it is also thrilling.

Sure, our numbers for utilization, as you will see in the following pages, continue to soar, keeping us in the top 25th percentile in the country for utilization. But we also lead the country in the breadth of user groups we serve. The users of ASTEC include middle and high school minority students who are discovering that the world of health care abounds with opportunities for them, in terms of finding learning challenges and future professions. We also have 8 first-responder organizations that contract with the University of Arizona (UA) to use our simulation facility and tap our expertise, in order to train the firefighters, the police, the United States Border Patrol, and the paramedics who protect and serve our communities. In addition, undergraduate students pursing a number of majors have developed projects and completed internships in ASTEC.

Of note, our curriculum covers all 4 years of the medical school curriculum. We serve no fewer than 10 residency training programs—many of which now require simulation as part of their postgraduate medical training requirements. More than 50 Arizona Health Sciences Center faculty members now teach in ASTEC, funding their hearts and expertise to immersive learning.

Twenty percent of ASTEC’s simulation training sessions take place within the confines of our UA medical center’s University Campus or on our South Campus. Under Dave Biffar’s stewardship, we continue to advance our innovative approach of developing artificial tissues on site for the vast variety of simulation trainings and have no less than 5 ongoing research projects in this area. The Arizona Telemedicine Program keeps teaching us that outreach can never be overreached.

Lisa Brihanj, ASTEC’s nurse practitioner, has launched new initiatives into immersive gaming to reduce medication errors. Dr. Jerry Rauschb, ASTEC’s director of research, is bringing aboard even more powerful software for sifting through big data, looking to diagnose and address medical adverse events in a global fashion. John Jarred, our education specialist, is finding new ways to challenge first responders and our hospital teams to explore partnership and team skills in medical simulation. And Hannes Prescher, ASTEC’s research specialist, has becomes the 10th student who has worked at ASTEC to go on to medical school!

Clearly, we not only teach healthcare, we become it—as it should be. We are very proud of all of the present and future leaders of health care who have shared in ASTEC’s growth. We are grateful to be the beneficiary of wonderful support from our College of Medicine, Arizona Health Sciences Center, and UA, whose leaders continue to encourage and inspire ASTEC to take on bigger missions and bigger challenges. Our motivated students offer us fresh dreams and insights to drive simulation further and harder in the 21st century. Most of all, we continue to evolve as an effective team. We are blessed by the efforts of so many, from paramedics, nurses, doctors, and pharmacists who teach and facilitate simulation, to our sister institution in Phoenix and to the larger network of centers around the country that collaborate to further immersive, experiential learning.

It is really the individual members and components that make the sum of ASTEC so much greater than its parts. For all of them, from the bottom of our hearts, we give our thanks and, now, our congratulations for achieving national certification as a simulation center of excellence.

Allan J. Hamilton, MD, FACS
Executive Director, Arizona Simulation Technology and Education Center (ASTEC)
ARIZONA SIMULATION TECHNOLOGY AND EDUCATION CENTER

GROWTH

ASTEC opened on August 5, 2005, and has now begun its 8th year of operation. Over the past several years, we experienced an exponential growth in utilization rates as demand for simulation training increased, both at the University of Arizona Health Network (UAHN) and from external first-responder organizations. Chronic overcrowding became the norm in our heavily used facility.

To accommodate our burgeoning training commitments, ASTEC relocated into a new facility in the College of Medicine in January 2012. We have now completed our 1st full academic year in the new facility. By increasing the size of our available training space to 2,000 square feet, we are now able to provide simultaneous training sessions with different training groups. It also allows us to provide separate educational space for lectures, group debriefings and other video-assisted review sessions.

Since 2005, our laboratory has provided a consistently high volume of simulation technology and education services for numerous UAHN departments as well as external first-responder organizations. ASTEC increased its utilization rates for all categories of participants during 2012-13, resulting in a cumulative total of 8,137 learner contact hours (LCHs) in a single year, as compared with 7,325 LCHs during 2011-12.

Even with our outstanding new facility, our available training space is 6,000 square feet below the national average for a college of medicine simulation center. Yet our education and training utilization rates are on par with some of the largest medical simulation centers in the nation. Overall annual participant utilization has increased by 11% from the academic year 2011-12.

We also continue to be among the most multidisciplinary medical simulation centers in the nation, providing medical simulation training throughout all of the UA medical center. In a continued effort to provide more immersive interprofessional training opportunities, 20% of these teaching activities are provided for multidisciplinary teams while on shift (in situ) within the departments of Emergency Medicine, Pediatrics, Surgery, and Labor and Delivery. We also provide simulation training to medical flight crews, fire departments, military and federal rescue personnel, community outreach workers, and students in precollege programs. In fact, in the past year, ASTEC allocated 21% of its total training hours to prehospital training groups, an increase of 11% from the previous year. ASTEC has truly emerged as the leading training center for the first-responder community in Tucson. Through innovations in mobile and interprofessional simulation education, we continue to exercise every strategy possible to avoid turning away anyone in the Arizona health care community.

TEACHING ACTIVITIES

More than 80% of our available weekly schedule is devoted directly to medical simulation training. Much of this time is filled by the following College of Medicine programs:

- Emergency Medicine Elective
- Surgery Clerkship
- Internal Medicine Clerkship
- Pediatric Clerkship
- Obstetrics/Gynecology (OB/GYN) Clerkship
- Year I & II Societies
- Year I Interprofessional Cardiopulmonary Resuscitation (IACPR)
- Year III Intersessions
- Year III Transition Block
- Cardiopulmonary Resuscitation (CPR) Elective
- Surgery Club

Utilization percentage breakdown for all users of ASTEC for AY 2012-13.

Total learner contact hours (LCH) for each academic year since 2006-07. ASTEC has experienced an overall 11% increase in utilization since AY 2011-12.

In-hospital programs include the following:

- Emergency Medicine Competency Codes
- In Situ Critical Decision Unit Codes
- In Situ Diamond Children’s Pediatric Intensive Care Unit (PICU) Codes
- In Situ Diamond Children’s Neonatal Intensive Care Unit (NICU) Codes
- In Situ Diamond Children’s Pediatric Stepdown Codes
- In Situ Labor and Delivery Codes
- In Situ Newborn Nursery Codes
- In Situ Radiology Code Review
- In Situ Cardiothoracic Surgery Codes
- In Situ Cardiac Intensive Care Unit Codes
- In Situ Emergency Medicine Codes
- Radiology Attending and Staff Codes

ASTEC continues to be a primary resource for first-responder simulation training:

- Tucson Fire Department Recertification
- Northwest Fire Department (NWFD)
- Air Evac Helicopter Program
- Arizona Lifeline Helicopter Program
- United States Air Force Pararescuemen
- United States Border Patrol
- Pima County SWAT (Special Weapons and Tactics) Team
- Rural Metro Fire
- Eastern Arizona College

Medical student in Surgery Club practicing bronchoscopy

Emergency medicine residents practicing intubation using a flexible fiberoptic bronchoscope
Over the past year, ASTEC has added 1 pediatric and 5 adult hospital units to our in situ training programs. We continue to see deep commitment and dedication from our department faculty to these programs. Significant strides have been made in standardizing the simulation curriculum and deploying faculty members as content experts and core educators. Leading these efforts is Vivienne Ng, MD, newly appointed coordinator for all simulation training for the Department of Emergency Medicine.

Josanne Paxton, MS, NNP, continues to use ASTEC for Neonatal simulation training for the Department of Emergency Medicine. Efforts is Vivienne Ng, MD, newly appointed coordinator for all simulation training for the Department of Emergency Medicine. Our wireless adult mannequin, we simulated the transfer of a patient from an outlying hospital to the cardiac intensive care unit (CICU). In this simulation, ASTEC functioned as the outlying hospital. The mannequin was placed on an intra-aortic balloon pump, an extracorporeal membrane oxygenation (ECMO) pump, and a mechanical ventilator, as requisite intravenous lines and monitoring leads were placed. The transport team (consisting of nurses from the CICU and pediatric ICU, a respiratory therapist, and a perfusionist) disconnected the mannequin from the bedside machines for placement on the mobile transport bed. Next, the mannequin was wheeled to a waiting ambulance, then secured for transport and transferred back to ASTEC.

The transfer team (all of the participating ECLS providers) maneuvered the mannequin into and out of the elevator and monitored the mannequin throughout the transport. In the course of the transfer, the battery on the ECMO pump failed. Without a backup, the perfusionist was forced to pump by hand, the ECMO circuit for the remainder of the transport. This Mobi transport exercise allowed us to examine important logistical and safety considerations and to explore potential problems involving human factors in the transport of severely compromised patients.

Under the direction of Kara Snyder, RN, we have initiated, for all interns, a formal ultrasound-guided central line training program. Intended to reduce infectious and mechanical complications associated with central lines, this program, now in its 1st year, provides a learning environment for increasing competency. Residents are evaluated using performance criteria developed by the University of Arizona’s Central Line Associated Bloodstream Infection Task Force. Our aim is to educate all incoming residents, every year, in the best practices of central line insertion.

ASTEC continues to play an integral part in the Department of Surgery’s Intensive Laparoscopic Training Course for general surgery residents. Under the direction of Carlos Galván, MD, associate professor of surgery, this course requires each resident to undergo prerequisite simulation training in ASTEC before moving on to 4 days of training in the operating room. Additionally, starting in the 1st year of residency, ASTEC provides a weekly Fundamentals of Laparoscopic Surgery (FLS) training course that prepares general surgery residents for the FLS examination required for completion of residency.

For the 2nd straight year, ASTEC hosted the 3-day national Transport Nurse Advanced Trauma Course (TNATC) for Arizona’s Air Medical Transport personnel. To increase the realism of patients’ trauma presentations, we incorporating customized artificial tissue models with bleeding capabilities into existing task trainers for cricothyrotomy, tube thoracotomy, pericardiocentesis, and intravenous access. One day of the course is designated for standardized patient scenarios that use an advanced trauma moulage kit for creating Hollywood-like effects.

ASTEC’s popularity continues to be demonstrated by the enthusiastic and positive data generated from feedback and satisfaction surveys. We have consistently scored in the 99th percentile from feedback and satisfaction surveys. We have consistently scored in the 99th percentile on anonymous feedback questionnaires and are clearly considered a favorable educational experience by all learner groups. In fact, the most consistent comment is that all current users of ASTEC would like more designated time for medical simulation education.
OUTREACH

As part of the College of Medicine’s community outreach effort, ASTEC is making simulation technology available to health care professionals in outlying communities. We provide internship opportunities for the Med-Start Summer Program, Camp Scrubs, the Tucson Urban League, and the Arizona Assurance Program. The objective of our outreach activities is to raise health care literacy among young and underserved populations in Tucson.

In June 2013, Anika Zhang, a high school student and former ASTEC volunteer, participated in the Bridges to the Nations outreach program, which provides medical services to underserved populations in rural northwestern China. One of more than 70 volunteers representing 10 different countries, Zhang credits ASTEC for preparing her for this experience. She pointed out that her hands-on training in the ASTEC workshops gave her the confidence to assist in basic surgical techniques.

David Biffer, ASTEC’s director of operations, was invited to give a lecture to the “Virtual Reality” elective class at Gridley Middle School in Tucson. He discussed current and future applications of 3D modeling and virtual reality in medical education and health care. Part of Raytheon’s MathMovesU initiative, the class teaches students how to apply concepts of modeling and design to create their own 3D models.

In the past year, ASTEC has repeatedly taken its ultraportable birthing simulator, MamaNatalie, to the Women’s Center at Northwest Medical Center in Tucson. Arizona’s 1st freestanding, self-contained medical facility dedicated solely to the medical needs of women, the MamaNatalie mannequin allows nurses and other staff members to practice treating birth-related complications, including postpartum hemorrhage and shoulder dystocia.

The following is a full list of regular outreach activities conducted by ASTEC:

- Neonatal Codes in Nogales
- Neonatal Codes in Sierra Vista
- Office of Multicultural Affairs Internships
- Arizona Assurance Program
- Tucson Urban League
- Advanced Cardiovascular Life Support (AEDS) Skills for Mexican Medical Students
- High School Pre-Health Fellowships
- Med-Start Summer Program
- UA Pre-Med Camp
- Camp Scrubs
- BASIS Summer A2 Telemedicine Program
- Summer Institute on Medical Ignorance
- High School Tech Educators

Additionally, ASTEC provides independent research opportunities for undergraduate and pre-medical students. In the past two years, four former independent study students have been accepted to medical school at the University of Arizona. We are proud to offer undergraduate the opportunity to conduct research and participate in creating medical simulation environments that help prepare them for medical school.

TEACHING MODULES

ASTEC continues to upgrade equipment where necessary to meet the rising demand of simulation training in medical education. This past academic year, we added several new individual task trainers for unlimited practice of routine and highly advanced medical procedures. These include a new adult airway trainer (with adjustable occlusion settings of the trachea and with the capability of tongue swelling) for practicing intubating patients with a difficult airway.

We have also added an articulating head model used with our central line trainer, for practicing correct head positioning while placing a central venous catheter. This has been an invaluable addition with the recent initiation of the residency-wide central line training program.

Our greatest increases in new training requests came from residents and hospital staff, as much of ASTEC’s focus this past year was on upgrading and acquiring medical training equipment. We were able to secure additional capital funding to acquire a new ventilator, 2 ultrasound machines, 2 intravenous infusion pumps, and 2 new patient monitors with G-CPR™ capabilities.

Since much of our training occurs within the UA medical center, we have also upgraded our ability to offer high-quality video-assisted debriefing at our in situ sessions by acquiring a new ultraportable B-line debriefing unit. Equipped with state-of-the-art recording and annotation capabilities, the debriefing unit allows us to provide directed, video-assisted feedback to trainees immediately after the training exercise. It also gives us the ability to annotate and debrief trainees on an iPad. The debriefing unit maximizes the learning potential of trainees and limits interference with their workflow. Our objective is to seamlessly and efficiently integrate simulation training into trainees’ schedule, with a level of realism that makes it part of the natural flow of their day.

In recognition of our mobile approach to simulation, we were invited to present at the Western Regional Human Patient Simulator Network in Phoenix and again at the Human Patient Simulator Network World Conference in San Francisco. The topic of both presentations was mobilizing simulation: how to make the most of patient simulators outside of the training facility.

ASTEC’s full range of medical simulation equipment is listed below:

- 4 adult patient simulators
- 2 birth simulators
- 2 school-aged simulators
- 1 infant simulator
- 2 newborn simulators
- 1 ultrasound simulator
- 1 virtual-reality laparoscopic trainer
- 6 laparoscopic task training stations (NEW 3D display upgrade)
- 1 neurosurgical microscope
- 35 specialized task trainers (3 NEW)

Medical student teaching basic suturing techniques to a pre-health undergraduate
Testing out a new method for creating viscous hollow organs.

David Biffer, ASTEC’s director of operations, was invited to give a presentation at the International Meeting for Simulation in Healthcare in January, 2013 to discuss the process of implementing an artificial tissue laboratory. In his presentation, he outlined how to become more involved in the fidelity of simulation training equipment while lowering consumable costs.

ASTEC was awarded a 2012 research grant from the Academy of Medical Education Scholars (AMES) to design and develop a highly realistic bleeding tissue pad. To prepare themselves for their clerkship years, medical students can repeatedly use the pad for practicing suturing.

The following is a complete list of artificial tissue models developed by ASTEC since our opening in 2005:

• Adult and pediatric peripheral intravenous access
• Arterial line placement
• Intravenous access
• Umbilical cord access
• Adult and pediatric chest tube
• Adult and pediatric pericardiocentesis
• Tibia compound fracture with arterial bleeding
• Uterus with ectopic pregnancy
• Various wounds for suturing
• Ultrasound-guided line placement
• Bifurcation of common carotid artery
• External carotid to internal carotid bypass
• End-to-side anastomosis
• Bowel anastomosis
• Silicone wound models with pressurized blood perfusion
• Adult silicone trachea
• Pediatric silicone trachea
• Capillary refill model
• Extracorporeal membrane oxygenation (ECMO) model
• Cesarean section (C-section) model
• Intravenous (IV) access tissue pad
• Thoracotomy tissue
• Abscess model (NEW)
• Burned skin model (NEW)
• Congenital adrenal dysplasia model (NEW)
• Jugular vein distention model (NEW)

In the past academic year, we have developed several new artificial tissue models for human factors research and for regular use in medical simulation training. These include a model to practice incision and drainage of cutaneous abscesses, a burned skin model that allows trainees to practice escharotomy procedures, and a congenital adrenal dysplasia model for use in complex pediatric simulations. We have also upgraded our existing chest tube and cricothyrotomy models with more realistic bleeding capabilities to achieve higher fidelity.

This past summer, ASTEC hosted UA undergraduate Biomedical Engineering intern Amanda Franzier. Interested in the applications of 3D modeling in medical simulation, she created a hollow viscous tissue model of a human uterus. Using SolidWorks, a 3D mechanical computer-aided design (CAD) program, she developed a stereolithography (STL) file to print a 3D mold. To create the hollow lumen of the organ, she inserted her artificial tissue mold into a self-assembled manual rotocasting machine. This was a proof of concept project: a motorized rotator can be used in the future to create models with much higher sophistication and realism. The uterus model has a high potential for use in simulation and could be used to practice delivery of early gestation pregnancies as well as B-lynch suturing techniques for the treatment of uterine atony in post-partum hemorrhage. We are looking to advance our use of 3D modeling and printing of actual organs in the future, which would enable us to integrate pathology into our artificial tissue design process and give our training sessions a new clinical dimension.

For the second straight year, ASTEC provided an interactive tour for a Biomedical Engineering Clinical Rotation Elective for undergraduate students from the University of Arizona. Students were challenged to identify applications of electrical, mechanical, and material engineering principles in designing medical simulation technologies.
ASTEC has initiated a number of new research initiatives this past year while continuing to pursue ongoing projects.

Telebation

Working with Dr. John Sakles (professor in the Department of Emergency Medicine), Dr. Jarrod Mosier (assistant professor in the Department of Emergency Medicine) and Emily Grover, MD, we conducted a study to compare the effectiveness of telepresent instruction (via FaceTime) with in-person instruction in teaching intubation to procedurally naïve medical students. This technology has important implications for inexperienced practitioners in remote medical facilities who do not have access to an expert in the field and require live assistance while performing this critical procedure.

Surgical Navigation Technology

We conducted a study (sponsored by Karl Storz Endoscopy-America) to determine the impact of a novel surgical navigation system on the ability of surgeons to more easily and precisely direct their assistants’ instruments to specific sites in a simulated laparoscopic field. We found that a coordinate system overlaid on the laparoscopic display significantly reduced the mean time required for assistants to identify each selected target. The same navigation system used in the clinical setting may increase the efficiency of instrument movement and reduce surgical time.

Transaortic Valve Replacement (TAVR)

We played a critical role in the implementation of a new transaortic valve replacement (TAVR) surgical procedure at the UA medical center. Using a unique interprofessional training approach, Dr. Robert Poston (medical director of the Adult and Robotic Cardiac Surgery Program) designed a series of cadaver team training sessions before conducting the 1st TAVR procedure on an actual patient. The sessions involved the rehearsal of potential catastrophes related to the TAVR procedure. We linked simulation software (MUSE) to the actual operating room monitors and projected relevant vital signs for the simulated patient. To signal deterioration of the simulated patient, we used alarms, as would be the case in a real procedure. The simulation technology was effective in eliciting a rapid team response and provided the opportunity for team members to practice in a high-stress environment.

Medication Errors: Virtual-Reality Game

Using innovative data-mining software developed by the Department of Electrical and Computer Engineering, Medical Asymmetric Threat Response and Analysis Program (MATRAP), we have begun implementing a systematic, risk-informed approach to addressing adverse medical events. Using data from patient safety network (PSN) reports, this program helps us create association maps of different variables related to adverse medical events. This approach gives us the ability to target our simulation training to particularly vulnerable areas of the UA medical center. With the support of a Caduceus Risk Management Process Improvement grant, we have already used MATRAP to discover that the rate of incident reports related to medication errors was 2 to 3 times higher than in any other category. To combat this problem, we have designed an immersive training game that reviews proper administration of patient medication. We are currently in the process of implementing the game in the UA medical center and hope it can serve as a continuing education module for all nursing staff.

Computer-Assisted Surgical Trainer (CAST)

Thanks to the leadership of Jerzy Rozenblit, PhD, ASTEC’s director of research, our work continues apace with his team in the Department of Electrical and Computer Engineering in refining the Computer-Assisted Surgical Trainer (CAST) system. The most recent version of the CAST system provides a mobile version of the surgical training platform. Integrating its artificial intelligence-based motion planning software into a computer tablet application, CAST-PV (portable version) provides a
portable trainer box that can be set up and deployed for training in any location. The new takehome CAST system offers trainees more autonomy in their learning process and reduces their reliance on the direct presence of, and feedback from, an attending surgeon. It provides live feedback and assessment, enabling web community integration for score uploads and comparisons. This allows trainees and attending surgeons to track progress. The system can be used with the full line of Karl Storz laparoscopic instruments. Our primary goal, as always, is to raise trainees to a higher level of proficiency without putting patients at risk in the operating room.

Mitral Valve Artificial Heart Model

We have begun working with 3D printing technology to develop artificial mitral valves. We hope to be able to readily reproduce patient-specific valve deformities in artificial models for surgical training. We have already devised a number of prototypes.

FUTURE INITIATIVES

We have just begun to realize the vast potential of the Medical Asymmetric Threat Response and Analysis Program (MATRAP) for creating powerful models of medical adverse events. We are looking to harness this data-mining tool to help us better understand the relationships between the vast number of variables that contribute to the high rate of adverse events in the medical center. Such data maps would allow us to design risk-informed simulation trainings that directly address the source of preventable errors. Big data analytics has opened the door for predictive abilities in health care and for smart training that includes simultaneous monitoring of progress.

We hope to continue to expand our interprofessional in situ training programs to continue to bring the most relevant, practice-based simulations to our trainees. To complement these programs, we also hope to continue to make advances in the application of virtual reality.

Given the expanding use of simulation in health care education – as documented, for example, in the 2011 survey by the Association of American Medical Colleges (AAMC) – and the increasing focus on interprofessional care, plans have been approved for an integrated, multidisciplinary medical simulation facility. We are in the process of applying for accreditation as an educational simulation center with the Society of Simulation in Healthcare (SSH).

We are looking forward to presenting our research at the annual meeting of the AAMC in November 2013.


Poster and Abstracts


Surgery faculty teaching residents the fine points of suturing technique

PUBLICATIONS


