Towards an Integrated Learning Environment…

The METI® Surgical Skills Lab

…covering all six Core Competencies

Simulation: The Link Between the Science of Surgery and the Science of Education

Background:

The quest to become a surgeon takes a trainee through four years of medical school, a minimum of five years of residency, and sometimes several years of fellowship in order to obtain very specialized training. During that time three types of skills are acquired: cognitive, psychomotor and affective. As all three skill types are developed and integrated during the latter years of the educational process, the surgeon feels ready to take on the full responsibility for care of the surgical patient. This process continues unabated throughout one's surgical career, as new procedures, devices and technologies are introduced at an unprecedented rate. The ACGME broke those skills into the six Core Competencies. Any modern Surgical Skills Lab has to be able to address all six competencies in a safe learning environment.

Now supporting General Surgery, Gynecology and Urology training with:

- Virtual Basic Laparoscopic Skills Training
- Hybrid Basic Laparoscopic Skills Training
- Box Trainer
- TURP Learning Module for VR trainer
- Robotic Skills Learning Module for VR trainer
- Ectopic Pregnancy Learning Module for VR trainer
- Lap Chole Learning Module for VR trainer
- iStan Human Patient Simulator
- METIVision for Audio Visual performance capture and assessment for all systems
- Learning Management System to integrate the simulators with the curriculum

Surgical education and the residency model as we know it can substantially be traced back to William S. Halsted. He is accredited with starting the first surgical residency-training program in the United States [1]. The basic apprenticeship model he created has change very little over the years.

The publication of a report on human errors in medicine by the Institute of Medicine piqued the public interest [2] and created a challenge for reform – in both education and processes in health care with associated measurement of progress.

The leadership who worked for change will eventually tell the exact chain of events that followed within the surgical societies. What we can surmise by reading the literature is that the American Surgical Association (ASA) convened a blue ribbon committee to report on the state of Surgical Education and make recommendations for change [3]. The American College of Surgeons (ACS) started an initiative to establish credentialed education institutes to make sure the critical elements of surgical education could be uniformly found at leading centers and set an example for others to follow [4]. The American College of Surgeons and the Association of Program Directors in Surgery (APDS) joined efforts to create a standardized, national surgical curriculum in three phases. This not only sets forth what has to be learned, but also defines how the various skills can be acquired and how outcomes can be measured to insure a uniform product which is a critical requirement for patients.

Finally, there is a mandate by the Surgical Residency Review Committee that every surgical residency program has to have a skills lab based on the latest technology by the end of 2008.

The confluence of all these events set the stage for the first major redesign of how surgeons are being trained. Are we in the midst of evolution or revolution? If we are changing only the *how,* it is an evolution in which we are doing *things better*. If we are changing the *what*, it is a revolution where we are doing *better things*. Only time will tell. From the educational perspective there is a drive to establish objective assessment as the standard of measure and proficiency based promotion to higher responsibilities, replacing the concept of program years.

The Leadership within the surgical societies is looking at simulation as a critical teaching and assessment tool. The beginnings of computer based medical simulators can be traced back 15 years. In those days, one could count medical journal articles published on the topic per year on one hand. Today we see that many each month. In the early days, just the mention that simulation would someday be used for certification and credentialing in a surgical meeting could be reason to be thrown out. Today, boards and committees within

professional surgical societies are embracing their use. The first 12 years or so saw almost no progress in acceptance; in the last few years have seen residency applicants making it part of their selection process.

When and why did this shift come about? The early days of simulation were already promoting the ability of simulations to measure just about anything imaginable, within technical skills. The first metrics looked at time and efficiency of movement and were almost immediately challenged as not saying much about what makes a good surgeon. From a technical side, we (ie, industry) immediately challenged the surgical educators to tell us what would be valid metrics. However, this challenge stimulated a series of conferences led by Dr. Richard Satava (University of Washington, Dept. of Surgery) and other thought leaders to define a taxonomy of surgical skills that had to be mastered and metrics to assess those and, finally, a taxonomy of surgical errors. Around the same time, Dr. Richard Reznick (University of Toronto, Dept. of Surgery) was publishing a series of landmark articles on assessing surgical skills based on trained observers, multiple simple tasks and a standardized rating schema.

To attest to the speed of change, the ACS has already accredited the first 18 centers (*http://www.facs.org/education/accreditationprogram/list.html*), since the concept was first publicly discussed, about three years ago. The blueprint and requirements established by the ACS and instantiated in these institutions is a perfect benchmark for establishing a new integrated skills lab.

The first phase of the curriculum project is now complete (http://elearning.facs.org). The first phase focuses on Basic Surgical Skills, with Phase II to address key surgical procedures and Phase III to address team based performance for the Surgical Team.

Given that the current surgical education model has been in use for a century with minimal change, what we are witnessing today is no less than a revolution. Not only are we seeing the introduction of new technology to change the training venue for basic skills from the OR into Skills Lab's, but also we are seeing the creation of new teaching models. The educators who have embraced simulation and are creating the 21st century teaching models are also developing new ways to teach based on the enabling 21st century tools [5,6].

In retrospect, change will seem to have happened at break-neck speed. Changing the course of history can not measured in a single moment, but in the slow progress that moves us toward that goal.

KEY ELEMENTS IN AN INTEGRATED SKILLS LAB

The **Learners** in an integrated skills lab cover the whole spectrum: from medical school students and novice residents to the long time practitioner in the field, all members of the surgical team and allied health professionals across many specialties of surgery.

The **Training Methodology** changes over the years: a structured curriculum for the incoming novices, an adaptive method to focus on specific weaknesses and needs identified in the OR for the advanced learner, and a procedure specific approach for the practitioners who want to add a new procedure or technology to their practice, as well as skills maintenance throughout their career.

The **Curriculum** defines the educational plan: what content is taught, how the content is taught, what the competencies of the learners will be when they "graduate." Finally the curriculum prepares the learner and faculty for the individual learning encounters.

The **Curricular Content** includes didactic, psychomotor and affective components. The focus is on all aspects of patient care as defined by the Accreditation Council for Graduate Medical Education (ACGME) general competencies.

The **Educational Team** at the Lab has to use a robust educational design process to create, deliver, assess and improve the courses that are offered. They have to have a process in place to validate their curriculum, follow the long-term success of their learners and adjust what they offer accordingly.

Part of these efforts then extends into educational research and multi-institutional studies.

Faculty within an Integrated Skills Lab has a new role to play: they are a guide through an ever-increasing maze of information, they have to be able to provide a learning experience on-demand and help the learner challenge their current beliefs. Once the required knowledge and skills have been acquired, faculty has to be able to follow the learner into practice to close the loop and ascertain that the learner can apply the knowledge by being a proctor to them.

In addition to the content and faculty, the center has to have other resources in place. Ideally the center will have access to a trained **educator** to oversee the learning experiences and support the faculty in developing new learning modules.

At the very least all skills labs will have to have identified a physician with a strong interest in education to play the role of an education director. Additional support personnel such as a lab administrator to schedule, manage and make sure all resources are ready and available has to be in place.

The curriculum, training methodology and number of learners will drive the number and type of **simulators** that have to be available to address the needs of the audience. A variety of types of simulation modalities will be needed, starting with simple box trainers and inanimate models to computer-based, interactive simulations to train psychomotor skills, surgical physiology and team-based performance topics. The lab will have to have a sufficient number of each of the simulators to deliver the training during scheduled courses,

as well as ad hoc training sessions as needed. The **data** generated by all of these activities has to be captured, analyzed and archived.

Policies have to be negotiated and put in place to make sure a Skills Lab is efficiently used. Good education is not a spectator sport and cannot be voluntary. It has to be a focused and deliberate effort with appropriate feedback. Effective policies balance the use of enforcement by attracting undesired attention to the learners' reluctance to participate, and enticement by giving them increased responsibilities as they progress within the curriculum.

A **steering committee**, bringing together the various surgical specialties and anesthesia with members of other OR stakeholders, has to periodically review the direction of the Skills Lab and the resources that are available to make sure that the training needs of their institution, as well as, the other targeted learners continue to be met.

Technology has to play a key role. Reduction in work hours for residents and increased awareness for patient safety has reduced the exposure residents get to the number, variety and difficulty of patient cases during their residency. Technology has to be implemented to prepare them for increased patient responsibility earlier and to compensate for reduced exposure.

Technology enables objective assessment of the learners' performance and has to continuously tailor the learning experience to the learners' needs. Finally technology has to take over some of the faculty chores, like record keeping, tutorials and managing the learning process, so that they can focus on the most valuable learning opportunities in the OR.

To best support learning objectives that cover cognitive, psychomotor and affective skills, appropriate technology platforms must be put in place. This platform has to represent both the anatomy and the physiology of the patient and allow the learners to interact with the patient representation to diagnose, treat and manage the patient in the context of simulated clinical experiences. The key technologies that support this model are Human Patient Simulators and Surgical Simulators, augmented with data capture, a Learning Management System and a database as the means to track and review the learners progress to continuously define what should be tackled next.

Human Patient Simulators are anatomical (i.e. full-body mannequin) and physiological (i.e., computer modeled) replicas of human patients, including adults, children and infants. Sophisticated mathematical models and instrumentation allow health care providers to assess, treat and monitor as the simulated patient automatically and realistically exhibits signs and symptoms of worsening injury or response to therapeutic interventions.

The Human Patient Simulator (HPS®) is used to simulate a patient in the operating room [5] or intensive care unit, while the more portable Emergency Care Simulator (ECS®) is used for pre-hospital or emergency department locations.

Surgical Simulators offer hands-on simulations for surgery (e.g., METI SurgicalSIM®).

This platform offers a continual learning system that allows the novice, the advanced learner, and even the practicing surgeon the ability to develop and test their technical, cognitive and medical decision-making skills in a safe environment.
Moreover, proficiency can be measured for aspects such as trocar placement, respect for tissue, suturing and teamwork skills. This platform is being expanded to cover open and robotic surgical skills, as well as extended into other surgical specialties, such as Urology and Gynecology.
In addition, in the development of course content, faculty needs to identify when a training device will enrich the learning experience and create the appropriate scenarios around them to effectively train the targeted procedure.

The METIVision™ package allows learning activities that take place on inanimate models, wet lab or even in the OR [6] to be captured, annotated, rated and stored within the Learning Management System alongside all computer-based simulation activities.
The Learning Management System helps manage all daily activities taking place in the lab, from assignment of learning objectives to the individual learners, collection of data on their progress over time, informing faculty of the results to balancing the utilization of the various resources in the lab. This system also supports the creation and delivery of new content over time.

PUTTING IT TOGETHER

Clearly, a carefully developed **road map** needs to be a cornerstone of each skills lab. The road map defines the specific skills, tasks and procedures that can be learned at the Skills Lab and how they relate to the surgeons' and the surgical teams' needs. It allows learners to develop a plan to reach their specific learning objectives. It has to be based on a thorough **needs assessment** that allows each institution to tailor the universal guidelines to their specific circumstances.

The curriculum then elaborates the course of learning for each objective. As the incoming learners vary in prior skills and knowledge, the curriculum defines the learning strategies and training methods and tools that will best lead to the educational objectives that have been established.

Both learners and faculty have to be active participants of this process, optimizing the path and adjusting it based on individual needs. The responsibility of an Integrated Skills Lab is ultimately to have all the resources in place to support the road map and curriculum.

OPERATIONAL SCENARIOS

An integrated Skills Lab has to be able to serve the health care system it is located in, as well as run courses for a broader audience, both regionally and nationally. One way to consider this multitude of requirements is to look at a series of operational scenarios.

ADVANCED COURSES

At the vary least; an integrated Skills Lab has to be able to run advanced courses for eight practicing surgeons. Past experience shows us that fewer participants make the course financially uninteresting while many more make it a challenge during the lab sessions. Typically those courses are organized to make best use of the weekend minimizing disruption to a busy practicing surgeon's schedule. These courses are structured around didactic material, lectures, surgical videos or live surgery video feeds, followed by hands-on skills, task and procedural training as required. Pre-course study requirements and test elements are used to complement the material covered. The process also extends to include on-site proctoring by faculty provided by the institution to assure successful assimilation of the new technique or procedure into the learners' practice.

The didactic material typically includes disease state, physiology and pre-, peri-, and post-op patient management information.

Multiple human patient simulators, used as a bedside teaching tool to practice physiology and team dynamics, best supplement this material.

All learners taking turns at different positions can allow the necessary content to be covered within the allocated two to three hours. Traditionally, reading journal articles and attending a lecture have covered this material. This method did not allow the course participants to assimilate the concepts and apply them in a simulated environment.

The acquisition of new skills and techniques would require multiple SurgicalSIM's, and inanimate box trainers. This setup would allow for training to take place in either a mentor-learner mode or have two surgeons work on the same task, teasing out what each hand needs to do, and how two surgical positions have to work together to accomplish a task.

RESIDENT TRAINING

A successful Skills Lab is jointly managed and used by multiple surgical specialties. This allows the available resources to be maximally utilized. General Surgery, OB/GYN, Urology, Orthopaedics etc., use many such labs as a joint resource. The Institute steering committee then works on the overall faculty requirements, with some cross training taking place and scheduling being centrally coordinated. The content offered extends beyond psychomotor skills to key surgical concepts, basics of anesthesia, and implications for various disease states, enabling resources to be maximally utilized.

The configuration should allow for as many as 12 learners to utilize the Skills Lab at a time. This would be in-line with the experience at some of the current, successful multi-specialty centers, such as Baystate Medical Center, Beth Israel Deaconess, and others.

Both faculty and learners then also engage in providing training to medical school students, allowing for the development of teaching skills.

TEAM TRAINING

The described resources can be configured to represent an ER, OR or ICU setting, allowing for team training to take place.

Elaborate scenarios can be constructed to focus on team dynamics, communication and resource allocation for surgical teams, or simply to prepare the individual to be a good team member.

OPERATING ROOM STAFF

Clearly the resources in the Lab must be used to provide training to incoming OR staff such as surgical nurses and physicians', both to complement what they have learned in their various educational programs and to familiarize them with the equipment and approaches used at the particular institution. Past this first round, the Skills Lab offers courses to allow them to take on increased responsibilities within the surgical setting.

Comprehensive Offering for an Integrated Skills Lab

The ACS Standards and Criteria to become accredited as a Basic or Comprehensive Education Institute can serve as an excellent benchmark to set you on the path to formalize and focus the educational resources you have to meet the new challenges of your surgical education mission.

The Standards address three domains that are then realized by addressing the corresponding criterion. Over twenty institutions were awarded the ACS accreditation, with many more working towards this goal.

METI is pleased to work with most of these institution and to be able to offer a comprehensive package to start you along the path. Here is how our offering addresses and supports the three Standards:

Learners

- Challenging educational tools that have been in use for Physicians, Residents, Medical Students, Allied Health Professionals, Nurses and others for many years
- Supporting teaching methodologies
- Tools and methods to assess the learners progress
- Scenarios for interdisciplinary training
- Access to our network of users representing hundreds of medical training institutions

Curriculum

- Tools and Learning Modules addressing both Procedural and Cognitive Skills
- Help with curriculum integration
- Tools and methods in support of objective assessment and continuous improvement

Technical Support and Resources

- Help with planning for expansions and personnel requirements, based on our involvement with many of the comprehensive centers in the US and abroad
- A set of core devices to give you a head start in the creation of a state-of-the-art learning environment
- Ongoing technical support to make sure your technology investment performs at its highest potential

There are many components that make up an efficient and effective Skills Lab. A key component is the glue that holds it all together, a Learning Management System that builds the bridge between the learner records, faculty, simulations, simulators and all key learning activities. This goes well beyond the individual simulations that get set up. The road map you develop allows you to gradually build this environment if you so choose.

The package that we are offering consists of:

• Four SurgicalSIM's (VR and Hybrid) that form the core for procedural skills training and can be shared by multiple specialties, such as General Surgery, GYN, Urology.
• A Human Patient Simulator that forms the core for cognitive training and addressing many of the six core competencies outlined by the ACGME
• An integrated METIVision and Learning Management System to support bench top training and human patient simulation activities
• Optional capability to record and assess Learner performance in the OR as part of a quality improvement process
•Options that support Anesthesia, Nursing, Intensive Care, Emergency Medicine, Trauma and Disaster Medicine Complete installation and administrative training on site
• Three days of intense on-site training on how to teach and assess using simulators by faculty that are the leaders in the field to prepare your educators and offer CME credit
• Educational content and scenarios to complement your curriculum and give you an instant start-up
• Five-year comprehensive maintenance agreement to protect your investment
• Access to our annual HPSN conference, and thus to hundreds of your peers that have been working with this technology for many years

Similar configurations are already in use at many leading institution worldwide. Our web site contains product information on each of these systems and a complete list of all of our users. We would be happy to arrange a visit to one of these institutions.

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4. Accreditation of Education Institutes by the American College of Surgeons: A new program following an old tradition - Carlos A. Pellegrini, Ajit K. Sachdeva, MD, FACS, FRCSC, Kathleen A. Johnson, EdM

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RECOMMENDED READING

Accreditation of Education Institutes by the American College of Surgeons: A new program following an old tradition - Carlos A. Pellegrini, Ajit K. Sachdeva, MD, FACS, FRCSC, Kathleen A. Johnson, EdM

ACS Accredited Education Institutes Program Requirements For Level I Comprehensive and Level II – Basic Education Institutes
For more information go to: www.facs.org/education/accreditation program

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Graduate surgical education redesign: Reflections on curriculum theory and practice - Debra A. DaRosa, PhD, and Richard H. Bell, Jr, MD, Chicago, Ill

Simulation-Based Medical Education: An Ethical Imperative - Amitai Ziv, MD, Paul Root Wolpe, PhD, Stephen D. Small, MD, and Shimon Glick, MD

Evaluating Clinical Simulations for Learning Procedural Skills: A Theory-Based Approach - Roger Kneebone, MB, ChB, PhD, FRCS, FRCS Ed, MRCGP

Metrics for objective assessment Preliminary summary of the Surgical Skills Workshop - R. M. Satava, A. Cuschieri, J. Hamdorf

Analysis of errors enacted by surgical trainees during skills training courses - B. Tang, MD, G. B. Hanna, PhD, and A. Cuschieri, FRS

"METI takes learning objectives and creates the platform for teaching and learning. METI does more than build a better mousetrap; they are getting surgeons to rethink competency assessment through simulation."

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www.BIDMC.Harvard.edu/SASC