

Technology innovations in global medical education

Author

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Abstract

The loss of 400,00 lives annually due to preventable, adverse outcomes is believed to be the third leading cause of death in the United States, after heart disease and cancer.

The leadership of the University of South Florida, Center for Advanced Medical Learning and Simulation (CAMLS) has heard this concern and developed a national model for improving medical education and patient safety, as well as aggressive and needed healthcare solutions through the use of cutting edge technology, innovation, and simulation.

CAMLS' goal is to use technology, simulated environments, and team training to transition medical education from an apprenticeship model to an evidence-based competency model that improves patient outcomes and reduces medical errors.

The processes used at CAMLS are reflective of the instructional design process and team training approach used successfully in aviation and the military.

What is CAMLS?

CAMLS is a 90,000 square foot, free-standing facility that is dedicated to the assessment of cognitive, behavioral, and technical competence for undergraduate, graduate, and postgraduate training of all healthcare professionals. The CAMLS' unique instructional design process is metric driven and uses simulators, online education, deliberate practice, and remediation to assure individuals and teams can achieve cognitive, technical, and behavioral proficiency within each learning experience.

Transforming medical education

This discussion focuses on a different perspective in terms of technology-enabled education, asking what has been learned from the aviation industry and military that is applicable to medicine. When we consider those things in healthcare that need to be transformed, there are multiple opportunities that come to mind.

Our clinical and academic enterprises have gaps that must be fixed, not incrementally, but through transformation. When one examines our hospital systems and looks at clinical performance, hospitals are helpless when it comes to senior physicians with frequent complications. We simply

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do not have a system in which we can detect, refer, remove, or mediate quickly and efficiently physicians who are having difficulties. Existing systems for hospital credentialing and privileging are report-based, not performance-based; there is no systemic, objective method to determine a physician's proficiency with a new technology. Mandatory continuing education (CE) for re-licensure is based on seat-time, not on clinical relevance that will improve patient outcomes (Figure 1).

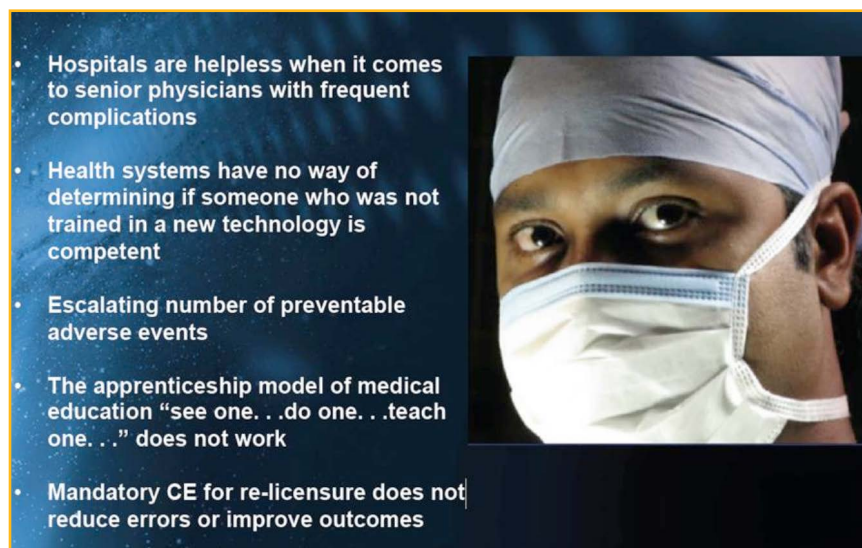
All of these "system failures" contribute to the escalating number of preventable, adverse events occurring in hospitals, which is estimated by some to be as high as 400,000 events annually.^{1,2} When one examines our academic models, we find that 100 years after the Flexner Report, our predominant approach is still the apprenticeship model. It assumes learning by observing a senior colleague and then practicing on patients, rather than using technology to assure performance prior to actually executing tasks or procedures for patients.

In lifelong learning, throughout the United States, our continuing education or postgraduate system does not have a significant impact on quality or improvement of patient safety.³ We know that mandatory continuing education for physician re-licensure does not reduce errors or improve outcomes. We do not have an integrated, comprehensive postgraduate education system that

focuses on correcting knowledge and performance deficiencies at either the individual or the system level. For example, we have no way of objectively determining whether or not a physician has the necessary training to demonstrate proficiency with a new technology (Figure 2).

A new medical educational paradigm

An analogy for us to consider is the aviation industry. In examining trends in aviation in the United States over the last 40 or 50 years, there has been a significant reduction in fatalities in airline accidents. The United States airline fatality rate is one-third of what it was in 1950. For the two years, from 2002 to 2004, not one person died in a domestic airliner. But how did the aviation industry achieve this? They practiced crew resource management, situational awareness, decision-making, and team skills building.⁴ They used best safety practices, emergency team management, standard operating procedures, checklists, and recurrent training to obtain and maintain skills. What is often not recognized is that in this model, the flight simulator is used in all stages of pilot training, retraining, and remediation. An additional influence on safety in aviation has been the Federal Aviation Agency, which requires reporting and intervention for even minimal accidents or errors, and a no-fault reporting system through the National Aeronautics and Space Administration (NASA).



- Hospitals are helpless when it comes to senior physicians with frequent complications
- Health systems have no way of determining if someone who was not trained in a new technology is competent
- Escalating number of preventable adverse events
- The apprenticeship model of medical education "see one. . .do one. . .teach one. . ." does not work
- Mandatory CE for re-licensure does not reduce errors or improve outcomes

Figure 1. Dealing with physicians with frequent complications.



Figure 2. Aviation and medical education.

When a pilot has a rough landing and it could be related to cognitive ability or skill level, the pilot is sent for remediation immediately — not in a year, not in six months, but immediately. This process has resulted in the standardization of training that assures consistent, predictable behaviors across all potential scenarios. Remember, the general public does not make its travel plans based on who is flying the plane. We have confidence that the system will assure our safety when air travel is required. Do you use the same approach when selecting a healthcare provider?

The effectiveness of simulation-based training in other industries offers an approach for consideration in medical education. It allows learners to practice clinical skills under controlled, safe conditions; undergo formative assessment; and receive focused feedback with the goal of acquiring and maintaining clinical competence.

The Center for Advanced Medical Learning and Simulation (CAMLS)

At the University of South Florida, we have taken concepts from aviation and applied them at the Center for Advanced Medical Learning and Simulation (Figure 3).

Our project represents an academic-entrepreneurial model, which means we have the best of the

academic and business worlds. We are part of the University of South Florida, Morsani College of Medicine; we have the academic imprimatur of quality by meeting accreditation standards required to educate learners from all health professional disciplines, but we are operated through a 501C3, not-for-profit corporation with a separate Board of Directors. We have the flexibility to operate like a small business with a sustainable business model.

CAMLS is where we are transitioning all of our medical education from the apprentice model (see one, do one, teach one) to a competency-based model, using multiple types of simulation. The types of simulation include: standardized patients, high fidelity simulators, task trainers, and a range of simulated environments to train individuals and teams using a metric-based model. Onsite, we also have a medical device development and commercialization center called the Tampa Bay Research and Innovation Center (TBRIC) that allows us to work with the medical device industry for usability studies, validation studies, and preclinical testing, among other things. Most of our translational research related to new product development occurs at TBRIC.

Another strength of the CAMLS model is that we are a new economic engine for the city of Tampa. CAMLS generated 12,900 new room nights for the city last year. In our first year alone, we had over

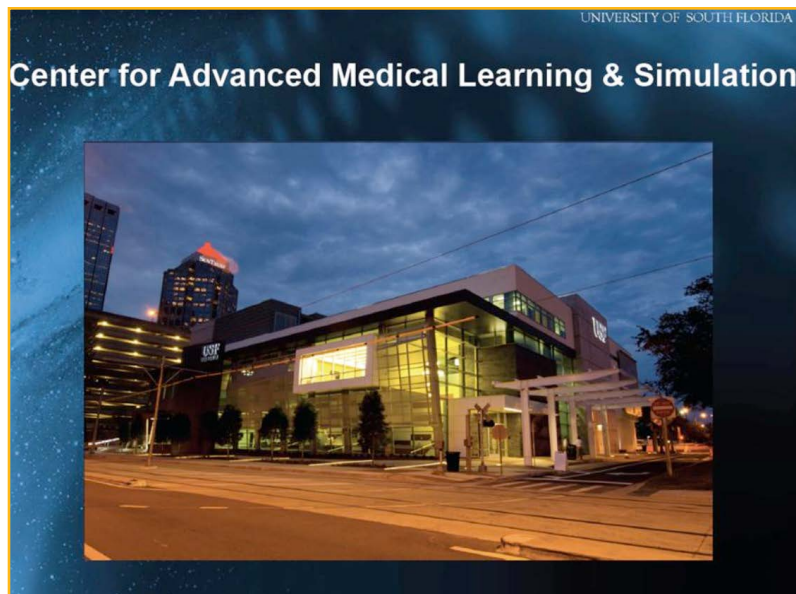


Figure 3. Center for Advanced Medical Learning and Simulation (CAMLS).

16,000 learners attending activities at CAMLS from over 60 countries. The majority used Tampa International Airport, stayed in our local hotels, and used downtown restaurants and other entertainment venues. This was a great boost to the local community during an economic downturn.

Components of CAMLS

Surgical and Interventional Training Center (SITC)

CAMLS is a unique and strategically planned facility with four very different components (Figure 4). On the first floor, there is the SITC, where we offer a variety of hands-on or competency-based learning that uses cadaveric or animal models, as well as high fidelity simulation. Learners in this area include surgeons in all specialties, interventional radiologists, and interventional cardiologists. Also, device companies use the SITC for sales and product training.

In addition to the 36 surgical skill stations, we have a functional trauma operating room, a hybrid operating suite, a CT scanner that we use for research, and a microsurgery suite that has four skills stations (Figure 5). In the past, our residents would attend training at an out-of-state venue at the cost of five or six thousand dollars per resident, and now, with

the SITC, training is available in-house, which has created cost savings for our residency program.

Virtual Patient Care Center (VPCC)

VPCC is what academic medical centers commonly refer to as a simulation center. This area is 10,000 square feet, dedicated to the use of standardized patients, team training, and high fidelity simulation for a variety of healthcare disciplines (Figure 6). The VPCC staff work with subject matter experts to develop scenarios, pre-brief learners regarding the scenario, operate the scenarios, and debrief the training activity. They also act as skills coaches for learners needing additional practice to achieve proficiency in tasks, skills, and procedures.

Tampa Bay Research and Innovation Center (TBRIC)

TBRIC is the component of CAMLS that works with subject matter experts to develop new products that enhance patient safety and improve care options. TBRIC services include preclinical studies, concept development design, usability and validation studies, and rapid prototyping services. These services have become a separate revenue stream and a feeder for the other areas of CAMLS. TBRIC is a one-stop shop for the medical device industry, with design and development, innovative education and training, and



Figure 4. CAMLS components.



Figure 5. Surgical Intervention and Training Center (SITC).

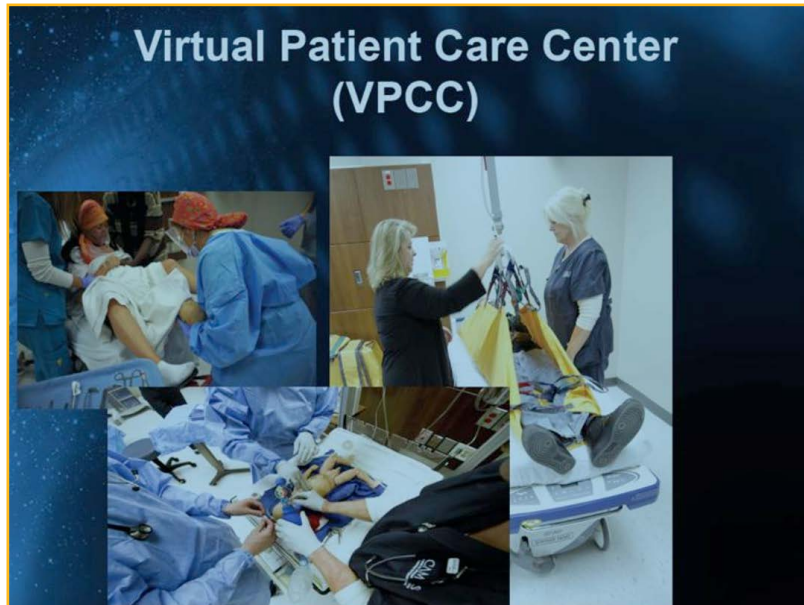


Figure 6. Virtual Patient Care Center (VPCC).

total immersion testing. Within design development alone, we offer user research, focus groups, contextual inquiry, concept development, engineering design, prototyping, regulatory controls, final design, and commercialization. The users of TBRIC are engineers, sales and marketing staff, and physicians (Figure 7).

Education Center

The second floor of CAMLS is devoted to classrooms, boardrooms, auditoria, and a dining room, and has the use of an audience response system and computer-assisted learning.

Who learns at CAMLS?

An amazing variety of learners come to CAMLS and TBRIC. Among others, we see undergraduate and graduate students, residents, Certified Registered Nurse Anesthetists (CRNAs), practicing physicians and other healthcare professionals for continuing education and training, physicians requiring remediation, physicians requiring retraining or reentry into practice, Emergency Medical Technicians (EMTs) and other pre-hospital providers, people training for the military and for

those making the transition from military to civilian life, industry sales representatives and clients for product training, medical specialty societies for regional workshops, researchers, and colleagues from other medical schools and academic entities. During our first year of operation, CAMLS reached over 16,000 learners from over 60 countries who were interested in the types of activities offered at CAMLS.

The instructional design process

One aspect of transforming medical education is to change the instructional design process itself. At CAMLS, we have adopted a modified ADDIE (Analyze, Design, Develop, Implement, Evaluate)⁵ approach, similar to the training process utilized by the aviation industry and the military. We have refined components of the task analysis, scenario design, checklist validation, debriefing, and simulation strategies to meet our needs in medical education. This instructional design process used with simulation and simulated environments creates a learning activity that leads to standardized outcomes across learners and facilitates the development of metrics that generate quantitative data to assist with determining a learner's proficiency.

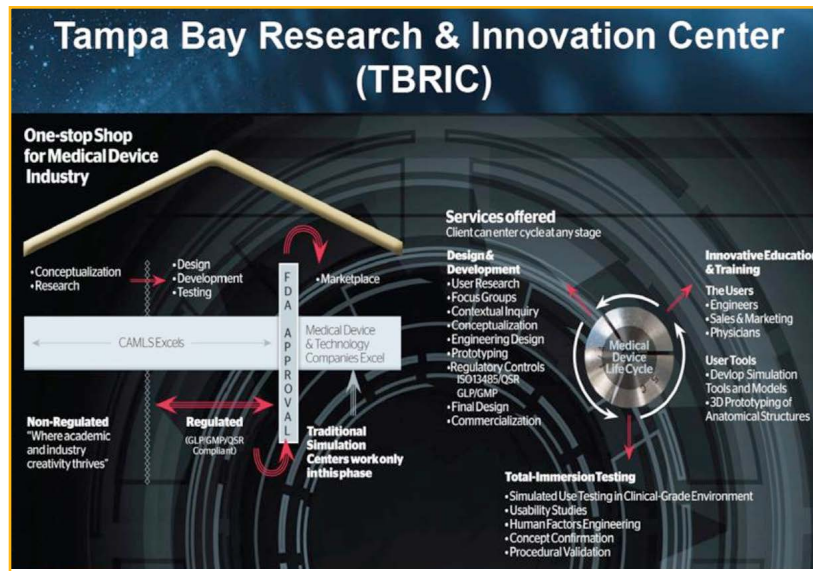


Figure 7. Tampa Bay Research and Innovation Center (TBRIC).

The instructional design process involves several steps:

- Preliminary Needs Analysis
 - Establish operational performance goal
 - Determine solution type
 - Conduct cost/benefit
- Training Needs Analysis
 - Conduct formal gap analysis
 - Conduct job/task analysis
 - Conduct learner analysis
 - Conduct organization/system analysis
- Instructional Design Planning
 - Develop instructional objectives
 - Performance standards/metrics
 - Develop performance assessment strategies
- Instructional Development
 - Conduct media analysis
 - Establish prerequisites
 - Develop didactic (lecture) materials
 - Develop computer/web-based components
 - Develop simulation scenarios/supporting materials
- Instructional implementation
 - Pilot/dry run course
 - Revise and finalize course
- Training Evaluation
 - Assess Level 1: reactions, self-efficiency, utility
 - Assess Level 2: learning
 - Assess Level 3: training performance

- Assess Level 3A: job performance
- Assess Level 4: organizational results
- Continuous Improvement
 - Revise/improve course

When conducting a task analysis as part of the instructional design, we develop a checklist that is used for training or for assessment. The difference is that a task analysis used for training has detailed performance metrics that allow us to perform a formative evaluation of the learner. We use this in training when it is important to evaluate the proficiency achieved for each step in learning a task, skill, or procedure.

When we use a checklist for assessment, the rating scale is different. We incorporate the concept of a global rating scale that includes critical elements that must be successfully achieved to satisfactorily advance in learning a skill or procedure. This type of approach is commonly used for summative evaluation.

Having a facility like CAMLS has allowed us to use this instructional design approach with many types of learners and for cognitive, behavioral, and technical learning exercises. We are pleased to report that the process is effective in measuring proficiency in all domains.

Future use of simulation

The medical community has recognized that simulation is a crucial training tool that will only grow in value. Consequently, there are workgroups through the American College of Surgeons and the Society for Simulation in Healthcare that are developing simulation scenarios, perfecting effective debriefing techniques, and reinforcing the need for deliberate practice. There are, at least, two companies that are developing what we call "Procedure Rehearsal Studios," which allow the importing of real patient data for use in simulated scenarios. This approach allows surgeons in high risk specialties to practice the procedure prior to performing it on a patient. The future of simulation lies in its use as a part of a clinical intervention to enhance patient outcomes.



Figure 8. CAMLS to Expand its Models.

Conclusion

The model described here differs from that used by most academic medical centers. It is based on user fees, foundation support, grants, and having a facility that is open to more than USF. The facility is available for any organization to rent. Organizations that typically use CAMLS include: medical schools, nursing schools, hospitals, medical specialty societies, and medical device companies.

Global solutions for curriculum reform emerge from our work to provide a metric-driven approach to instructional design that reduces the learning curve and produces consistent performance outcomes across learners; provides validated tools for the assessment of learners; uses simulation for individual and team training across all specialties; and integrates medical innovation, education, and research (Figure 8).

In our work, we remain focused on the well-being of the patient, with a goal of moving healthcare professionals from practice on patients to practice with simulation and performance for patients. The benefits of performing for patients will add to their quality of care and assure consistent performance by those who provide that care.

References

1. Sanders, Bernie (Ind.VT), Chairman, Senate Subcommittee on Primary Health and Aging, July 17, 2014.
2. James JT. New, evidence-based estimate of patient harms associated with hospital care. *J Patient Saf.* 2013;9(3):122 – 128.
3. IOM (Institute of Medicine). *Redesigning Continuing Education in the Health Professions*. Washington, DC: The National Academies Press; 2010.
4. Anca JM, Helmreich RL, Kanki BG. *Crew Resource Management*. 2nd ed. Amsterdam; Boston, MA: Academic Press/ Elsevier; 2010:79 – 110.
5. Branch R. *Instructional Design: The ADDIE Approach*. New York, NY: Springer; 2009.

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