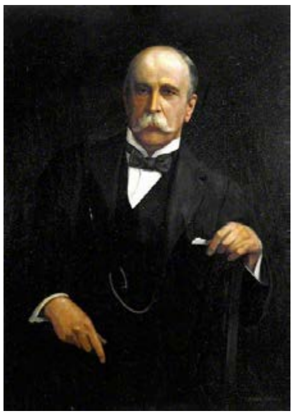
The Teaching and Evaluation of Clinical Competence – An Undergraduate Medical Education Perspective



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Internal Medicine Grand Rounds

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Purpose & Overview

All institutions engaged in health care education list as a mission to produce excellent health care providers. To assure the accomplishment of this mission and be more accountable to society, medical education is undergoing a paradigm shift to competency-based medical education. Over the past decade, consensus on trainee performance expectations at various levels is being built, successful methods of teaching and learning competencies are emerging from the literature, and reliable and valid instruments and systems to measure clinical competence are being designed.

The purpose of this internal medicine grand rounds is to review the state of the art of competency-based medical education and provide a glimpse into the future, both at UT Southwestern as well as more broadly.

Learning Objectives

1. Describe the importance of clinical skills to the modern and future physician.
2. Describe the history and evolution of the teaching and evaluation of clinical skills in medical education from "See one, do one, teach one" to competency based medical education.
3. List the main tools used for teaching and evaluating clinical competencies in UME.
4. Describe the important role each faculty member must play in the teaching and evaluation of clinical competence.
5. Describe the future of competency-based medical education in general and at UT Southwestern.

Introduction

"Case" reports, courtesy of Jason R. Frank, MD, MA(Ed), FRCPC, guest speaker at the 2012 Southwestern Academy of Teachers Symposium:

1. You are supervising a bright first year resident in July. While seeing a patient, he is embarrassed, and reveals that he has never sutured or performed an LP during his MD training.
2. Sonia is a final year student who has been flagged by supervisors as "difficult" and "incompetent". She has scored well on all exams, but no nurses want to work with her, and junior residents call her "dangerous". She is only a few months away from graduating. Faculty debate whether to "just pass her".

These "case" reports will likely seem familiar to the seasoned faculty member, and well illustrate a major problem facing medical education. Traditional medical education has focused on basic knowledge outcomes rather than clinical outcomes, which have come to be known as competencies. Competency-based medical education is a new paradigm for learning, and it focuses on the mastery of clinical knowledge, skills, and attitudes in the context of patient care. To begin our discussion, several fundamental questions should be addressed.

Are clinical skills important to the modern physician?

The modern physician has a growing number of tests and technology to diagnose patients. However, studies over the past four decades have consistently shown that the simple history accounts for 70-80% of diagnoses, with further testing adding only about 5%.[1-4] In fact, communication skills alone influence patient outcomes.[5] A 1995 metanalysis revealed 16 of 21 studies reported improvements in emotional health, symptoms, function, physiologic measures (i.e., blood pressure and blood sugar level) and pain control.[6]

Are our learners mastering these important skills?

Unfortunately, the literature supports poor mastery of clinical skills in trainees.[4] Studies of medical students document that communication skills rise, then fall by the fourth year.[7] The author speculates, "regardless of the effectiveness of a curriculum intervention which focuses on interviewing skills, other aspects of the curriculum may intervene to reprioritize what the student has learned, hence affecting the student's ability or willingness to practice what they have learned." Studies of the physical examination document poor cardiac auscultation skills of clerkship students: they are only able to identify 20% of common auscultory events.[8]

Studies of residents document equally poor skills. Cardiac auscultation is no better than clerkship students in three English speaking countries; the mean scores for identifying twelve cardiac events ranged from a mean of 22% for American trainees, a mean of 26% for Canadians, and a mean of 20% for British trainees.[8]. Further, residents in an internal medicine residency demonstrated poor content, questioning technique, and interview style when their history-taking skills were scored against a checklist.[9]

Unfortunately, but not unexpectedly, this poor performance extends to practicing physicians.[10] Practicing physicians were evaluated by standardized patients for their clinical skills and diagnostic prowess. Across all cases, physicians obtained a mean of 59% of history items deemed as essential. Examples of missed items include:

1. 69% of physicians did not ask a 34-year-old male patient with a resolving cough about his past medical illnesses, and hence missed his history of hepatitis B, missing a diagnosis of AIDS;
2. 52% of physicians did not ask a 27-year-old female patient with urinary frequency and burning and undiagnosed pregnancy about date of last menstrual period; and
3. 56% of physicians did not ask a 60-year-old man with fatigue and weight loss related to undiagnosed lymphoma whether he had night sweats.

Addressing how clinical skills can be better learned and documented will be the focus of this grand rounds.

History: The evolution of our thinking about clinical skills

Traditional, twentieth century medical education was conducted in separate silos, with little communication and coordination between undergraduate, graduate, and continuing medical education; not to mention other health professions like nursing, physician assistants, physical therapy, pharmacy, and social work, to name only a few.

Many will recognize one similarity among the silos: the maxim of "See one, do one, teach one" (SODOTO). This maxim had a solid philosophical foundation, being guided by John Dewey's educational progressivism movement and experiential education philosophy. However, the manner in which this theory has been practiced in medical education has recently been questioned.

One of the most remarkable studies challenging SODOTO compared lumbar puncture (LP) skills in 58 postgraduate year (PGY) 1 internal medicine residents to 36 PGY2, 3, and 4 neurology residents from 3 medical centers. The internal medicine residents received simulator-based training intervention in LP and the neurology residents learned in the traditional SODOTO manner. The results revealed PGY1 internal medicine residents improved from a pretest mean of 46.3% to a post-test mean of 95.7% after the simulation intervention ($p < 0.001$) and all met the minimum passing score determined by a panel of experts at final posttest. The performance of SODOTO trained neurology residents was significantly lower than simulator-trained residents (mean 65.4%, $p < 0.001$) and only 6% met the minimum passing score.[11] An editorialist in the journal in which this study was published heralded the death of the SODOTO maxim.[12]

Yet SODOTO does not exactly capture the spirit of the progressivism movement. John Dewey wrote, "If a man's actions are not guided by thoughtful conclusions, then they are guided by inconsiderate impulse, unbalanced appetite, caprice, or the circumstances of the moment." What is missing in SODOTO is reflective practice, or what K. Anders Eriksson calls "Deliberate practice."[13] Ericsson writes,

> *"How expert one becomes at a skill has more to do with how one practices than with merely performing a skill a large number of times."*

In this model, a trainee becomes an expert by breaking down to components the skills that are required to be expert, focuses on improving those components, often with immediate feedback from other experts. Deliberate practice also involves continually practicing a skill at increasingly challenging levels until it is mastered. The impact of deliberate practice was realized in the nineteenth century:

> *"In their classic studies of Morse Code operators, Bryan and Harter (1897, 1899) identified plateaus in skill acquisition, when for long periods subjects seemed unable to attain further improvements. However, with extended efforts, subjects could restructure their skill to overcome plateaus. Keller (1958) later showed that these plateaus in Morse Code reception were not an inevitable characteristic of skill acquisition, but could be avoided by different and better training methods. Nonetheless, Bryan and Harter (1897, 1899) had clearly shown that with mere repetition, improvement of performance was often arrested at less than maximal levels, and further improvement required effortful reorganization of the skill."[13]*

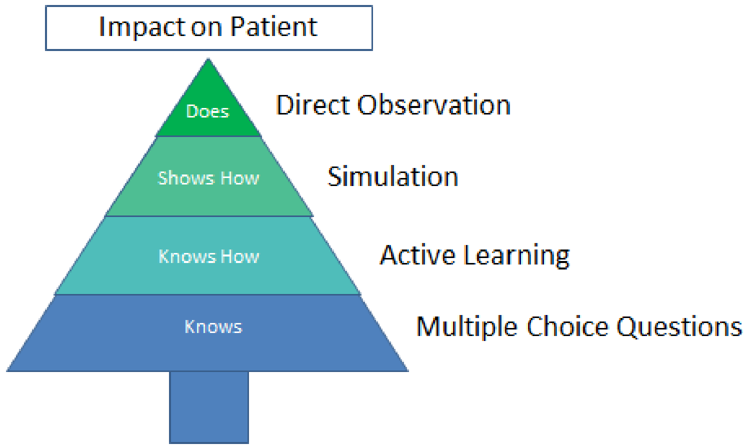
The questioning of the SODOTO model as well as the desire to be more accountable to society has driven criticism of the traditional method of medical education. Some authors call traditional medical education the "tea bag model", in which trainees are dunked for a defined period prior to graduation, without attention being paid to meaningful clinical outcomes.[14] These same authors have been major proponents of competency-based medical education (CBME), which is now widely viewed as the new paradigm in medical education.

CBME has been championed primarily by graduate medical education, through the Accreditation Council on Graduate Medical Education's (ACGME) Outcomes Project, which has now come to fruition with the Next Accreditation System.[15] The ACGME has defined a framework of competencies, sub-competencies, and milestones for all U.S. residencies; others have added to the ACGME's framework by introducing Entrustable Professional Activities (EPAs).[16]

This framework is now being mapped across the full spectrum of medical education, crossing into other silos. The U.S. University of the Health Sciences has created a curriculum matrix across the undergraduate medical education (UME) and graduate medical education (GME) spectrum.[17] The Association of American Medical Colleges (AAMC) has recently introduced the Core EPAs for Entering Residency (CEPAER)[18, 19], and the UT System has mapped competencies from the undergraduate setting into medical school through its Transformation in Medical Education project.[20]

Teaching and Assessing Competency

Hawkins and Holmboe describe three dimensions of clinical competence assessment: the competency to be assessed, required level of assessment, and trainee's stage of development.[17] The ACGME has provided the framework for the first dimension. George Miller's assessment pyramid[21] was adapted by Hawkins and Holmboe[17] in a way that nicely illustrates the level of assessment dimension. Figure 1 shows their adaptation, with slight modifications for the purpose this grand rounds. The third dimension is captured by Dreyfus and Dreyfus' stages of learning from novice to expert.[22]



George Miller's Pyramid

Figure 1

Figure 1 illustrates the progression of the assessment of a trainee's abilities from basic knowledge (the bottom of the pyramid) through performance of patient care. Holmboe and Hawkins added the primary tools used at each level. The assessment of knowledge through the ubiquitous single-answer, multiple-choice question (MCQ) examination is our most robust tool, one that for many years served as the sole measure of a trainee's competence. However, the limitations of MCQ tests are now well known when measuring a health care provider's competence, and this limitation is well captured in Miller's pyramid.

As a trainee progresses toward the tip of the pyramid, where patient care is impacted, the tools are newer, less well studied, and more complex. Figure 2 provides an example toolbox for CBME.

Example CBME Toolbox

- Standardized examinations
- Simulation
  - Standardized patients
  - Simulators
    - Computer-based education
    - Virtual reality
    - Task trainers
    - Computer-enhanced mannequins
- Direct observation
  - Mini-CEX/CEX
  - 360 degree evaluations/Multisource feedback
  - Medical record audit/chart-stimulated recall
  - Checklists/Global Evaluation Scales
- Portfolios

Figure 2

Holmboe and Hawkins provide a matrix of which tools to use in which part of the medical education spectrum.[17] Although simulators are not listed for undergraduate medical education, many feel they play an important role in this early part of the spectrum, too.

This grand rounds will review the assessment tools available for the top two levels of Miller's pyramid, as they represent the ones most pertinent to this audience. Simulation comes in the form of standardized patients (SPs) and simulators. Simulators are devices on which a trainee may demonstrate skill ("show how") on non-human subjects. Simulators have been rigorously studied and yield impressive results, especially when linked to mastery learning.[23] The use of simulators was recently reviewed in this venue[24], and will therefore be reviewed only briefly in this grand rounds.

Standardized Patients

SPs were developed by Howard Barrows in the 1960s at UCLA, USC, McMaster, and SIU. As a neurologist and educator, he wanted to find a way to simulate neurologic conditions, and he found laypersons could be trained to convincingly portray these conditions. The technique was picked up and studied by others, who discovered that SPs could visit practicing physician clinics without being detected as "simulated" patients.[25, 26]

Barrows listed the following benefits of SPs;[27] they:

1. Are available any time in any setting
2. Present the same problem to all students
3. Avoid mistreatment of patients
4. Can be examined over and over
5. Are prepared for inadequate performance
6. Are prepared for inappropriate remarks
7. Prepare students for transition to real patients
8. Allow student experience with emergency situations and sensitive medical conditions (dying, comatose, sexually abused patients) one would not allow the student to work with in real patient settings.

SPs are best used to teach and evaluate clinical and communication skills. In addition to routine history taking and physical examination skills, SPs have been used for more advanced communication skills, like delivering bad news and code status discussions.[28] The literature suggests being trained with an SP on one bad-news delivery scenario helps with other such scenarios.[29] Code status discussion skills have been demonstrated to be retained twelve months after the SP encounter; the discussion was of a higher quality and the discussion only took three minutes longer.[30]

SP encounters can be grouped into Objective Structured Clinical Examinations (OSCEs). Student performance on OSCEs may be evaluated by experts, trained SPs, or trained students; all these options seem to perform equally reliably for communication, language, and, with training, simple mastery of history and physical exam techniques.[31] OSCEs have robust enough psychometrics to be used in high stakes examinations. For this reason, SPs have become an important part of licensure of physicians in 7 countries (Australia, Canada, South Korea, Switzerland, Taiwan, the United Kingdom, and the United

States.[31] SPs are used on 5 continents in 50 countries (Figure 3), in 25 health care related professions (e.g. medicine [87%], nursing [5%], dentistry [3%] and pharmacy [2%]), and in all phases of education (undergraduate [58%], postgraduate [19%] and continuing medical education [4%].[32]

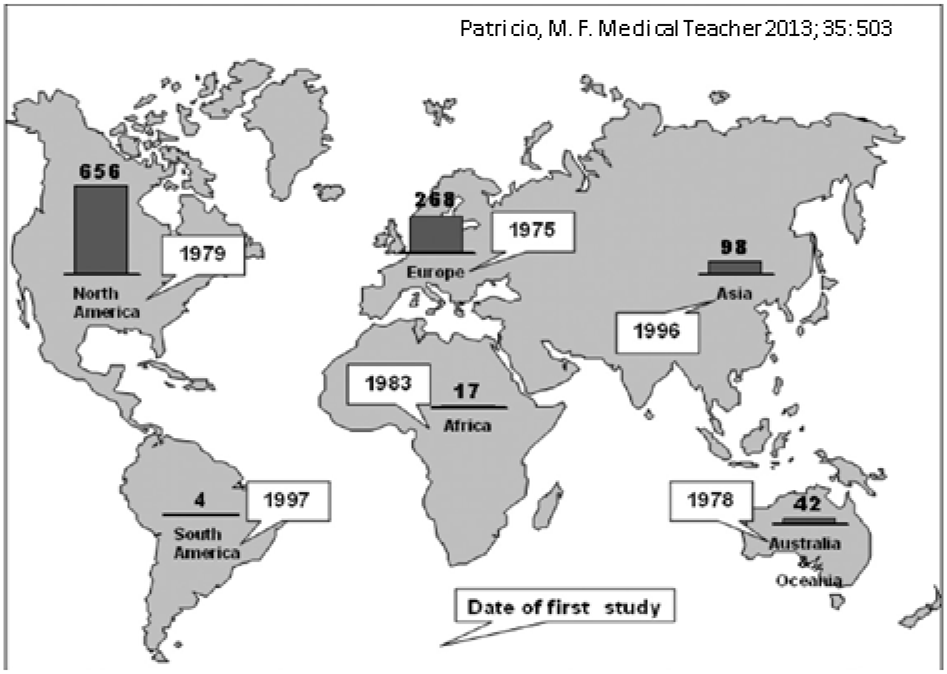


Figure 3: SP Publications by Continent

Direct observation

Appropriately at the pinnacle of Miller's pyramid, direct observation is very important and the least developed of all the CBME tools. Faculty are the primary source of trainee observation, but observation of trainees by all members of the health care team through 360 degree or multi-source feedback techniques is also important.

There are many obstacles to high quality, direct observation. As discussed above, faculty may not have well developed skills themselves, and therefore may not recognize poor skills in trainees. Further, faculty may rarely observe the provision of patient care. Rare student observation by faculty was noted in a study based on 97 LCME accreditation visits between 1993 and 1997.[33] Rare resident observation by faculty was noted in an ABIM pilot of a mini-CEX in five Philadelphia programs; a mean of four 20 minute observations over a year of training was viewed as burdensome.[34]

Rater errors are another obstacle to high quality direct faculty observation of trainees. Because patient care is not observed in trainees, Holmboe observes that faculty may only evaluate residents on two of the six competencies (communication skills and medical knowledge)[4], an observation supported by factor analysis of trainee evaluations. An evaluation of 1,039 ABIM evaluation forms filled out by 135 attending physicians on 85 internal medicine residents revealed one factor accounted for 86% of variance, the majority of residents scored between a six and a nine, and the form did not discriminate the residents rated at six from those rated at nine.[35]

There are two major types of rater errors: correlation and distribution errors. The above error is an example of a correlation error. Another example of this type of error is the **halo error**. A halo error occurs if a trainee is good at one component of competency and is then rated as good for all competencies, despite his/her actual performance.

There are two types of distribution errors: leniency/severity errors and range restriction. Leniency/severity errors occur when "hawk" faculty always rate trainees poorly and "dove" faculty always rate trainees favorably. Range restriction occurs when faculty do not use the entire spectrum of an evaluation tool.

Solutions to the Direct Observation Problem

Frameworks for Direct Observation

A simple aid to combat range restriction is to use frameworks. For example, the use of the RIME framework (Reporter, Interpreter, Manager, Educator) has been shown to distribute evaluation scores better than simple, global numeric ratings.[36] In this study, 97 students were evaluated over a twelve week internal medicine rotation; they were evaluated both with the traditional (at the time) global numeric score and the RIME, descriptive framework. The RIME technique yielded a much better distribution of evaluations (Figure 4).

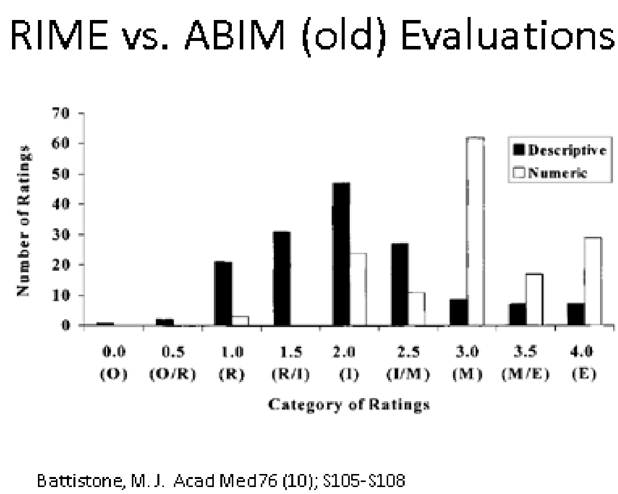


Figure 4

The success of the RIME framework prompted a long search for even better methods to evaluate trainees. However, it soon became clear that a Holy Grail of evaluation form that would solve all the problems with direct observation was not to be found. Other aspects of evaluation needed to be improved. In the words of a well-respected expert, "We need to stop searching for the perfect evaluation form and start training evaluators."[17, 37]

Faculty Development of Direct Observation

Holmboe and Hawkins describe four tools for faculty development in direct observation:

1. Behavioral Observation Training (BOT)
2. Performance Dimension Training (PDT)
3. Frame of Reference Training (FORT)
4. Direct Observation of Competence Training (DOCT)

BOT instructs faculty in simple behavioral interventions that improve direct observation. PDT engages faculty in dialogs about frameworks in a manner that improves their understanding of and investment in direct observation. FORT standardizes faculty ratings of observations through the use of video tapes and faculty focus groups. DOCT is a combination of several of these techniques. We'll explore BOT and DOCT in more detail.

BOT encourages faculty to increase the number of evaluations of trainees and offers several observational aids. For example, faculty are encouraged to keep behavioral diaries on each of their trainees with regular entries on what one thing was observed this day the trainee could improve upon, what one thing was done well, and what one recommendation for improvement the faculty would make. At the end of the evaluation period, the faculty member could review these notes and synthesize them into thoughtful, well-informed feedback. Several authors suggest such an observational aid could be available to faculty as a smart phone application or other, similarly easily accessible technology.

BOT also recommends preparing for the direct observation by considering what is to be observed, how one will position oneself for the observation, and how one will confirm the reported findings. For example, if a physical examination is to be observed, what components will be expected to be performed? How should they be performed? How will one observe without interfering with the performance of the physical examination? When will one examine the patient to confirm the findings the trainee reports?

Checklists and global evaluation scales are examples of other observational aids that are commonly used to improve the quality of direct observations. Checklists have been demonstrated to work well for procedures like thoracenteses,[38] central venous catheters,[39] and MICU ventilator management.[40] "Boot Camps", designed for trainees prior to beginning residency, have successfully used these tools to refine skills in cardiac auscultation, paracentesis, lumbar puncture, MICU ventilator management, and code status communication.[41] Faculty at UT Southwestern have published their successful experience with global evaluation scales.[42, 43]

Studies have documented the importance and efficacy of DOCT. Without training, 70% of faculty rate videos of resident performance as "satisfactory" or "superior" when the same video is judged by experts as scenario as "poor."[44, 45] Simple interventions don't help. A randomized, controlled trial of a simple training video did not improve faculty performance in direct observation.[44] However, a more intensive intervention demonstrated improvement in the quality of faculty direct observation. This controlled trial of 40 faculty from 16 internal medicine residency programs tested the efficacy of an intensive, four day course. The intervention made faculty significantly more comfortable with direct observation and more stringent in their evaluations with a tighter range. This effect persisted when it was measured eight months later. The authors have since recommended DOCT interventions lasting between 1.5 hours and two full days.[17]

The Future of CBME

CBME will only come to fruition with a full engagement of digital recording and data-management technologies. Reams of data on each trainee will be generated: digital recordings of encounters with standardized patients, mentors' evaluation of these encounters, scores from checklists evaluating various training exercises, and performance on standardized, written tests on medical knowledge. The only question about technology's role is the depth of its involvement.

Computers and Competency-Based Education.

At the very least, technology must be used to organize these data and present it to faculty in an easily understood manner. Otherwise, chaos could ensue. Susan Etlinger, an expert in analytics, states in her TED Talk about big data that we run the risk of realizing Aldous Huxley's "Irrelevant, trivial future" without organizing our use of these data.[46]

A meaningful use of these data could include any of the following. The dean could easily review whether the educational mission is responding to new initiatives. The course director or program director could easily identify a struggling student or resident and intervene. A resident or student could review weaknesses to focus on improvement and understanding strengths to help guide career choice. An e-portfolio could be produced for residency or fellowship application.

Some authors believe technology will assume responsibility for some of the competencies. Vinod Khosla, the US Billionaire co-founder of Sun Systems, writes,

> *"Diagnosis and treatment planning will be done by a computer, used in concert with empathetic support from medical personnel selected more for their caring personalities than for their diagnostic abilities. No brilliant diagnostician with bad manners, a la 'Dr. House,' will be needed in direct patient contact. Instead, we'll use 'Dr. Algorithm' to provide the diagnosis, while the most humane humans provide the care. … Most commercial flying is now done by autopilot, not by the captain. Algorithmic trading now drives most stock market volume. Google's self-driving Car has had zero accidents driving 300,000 miles on normal streets." [47]*

IBM's supercomputer Watson (2,880 processor cores and 15 terabytes of reference work) beat Ken Jennings and Brad Rutter at a widely viewed game of *Jeopardy!* in a 2011 series of matches. Jennings had a 74 game winning streak in 2004, and Brad Rutter was the undefeated champion at the time of the match with Watson. In an interview with *Slate* magazine after the match, Jennings calls Watson the "New overlord" and goes on to state,

> *"IBM has bragged to the media that Watson's question-answering skills are good for more than annoying Alex Trebek. The company sees a future in which fields like medical diagnosis, business analytics, and tech support are automated by question-answering software like Watson. Just as factory jobs were eliminated in the 20th century by new assembly-line robots, Brad and I were*

the first knowledge-industry workers put out of work by the new generation of 'thinking' machines. 'Quiz show contestant' may be the first job made redundant by Watson, but I'm sure it won't be the last."

Given the sources, these predictions must be taken seriously. In this author's opinion, this may be the future, but it's not a future this author would enjoy as a physician or a patient and it is not yet here. At the very least, CBME will need technological support to monitor competencies.

The State of CBME at UT Southwestern

There are several exciting developments in CBME on our campus. Many groups have developed sophisticated programs in isolation in various parts on the campus, and have just recently become aware of each other. An introduction of these resources to the rest of the campus is in order, and there is great potential for collaborative projects in the future. What follows is a review of our current CBME assessment resources.

Southwestern Center for Minimally Invasive Surgery (SCMIS), our most advanced and active center. It was founded in 1998, and its director, Dr. Daniel Scott, has published 80 papers on simulation. The Center features multiple simple and advanced task trainers designed to promote deliberate practice of surgical, laparoscopic, and endoscopic skills. SCIMIS is accredited as a Level 1 (comprehensive) Accredited Educational Institute by the American College of Surgeons and as a Fundamentals of Laparoscopic Surgery Test Center by the Society of Gastrointestinal and Endoscopic Surgeons. It is supported by the school and the departments of surgery, obstetrics and gynecology, urology, and anesthesia. Learners come from across the entire spectrum of medical education, including medical, nursing, and physician assistant students; residents and fellows; and practicing physicians returning for continuing medical education.

Department of Anesthesiology Human Simulation Center, within SCMIS, is a virtual operating room measuring 18 feet by 20 feet, is an exact replica of a modern-day operating room. It is equipped with live functional laparoscopic equipment needed for surgical-nursing-anesthesia team training and a SimMan 3G state-of-the-art mannequin. The simulation lab is equipped with a functioning anesthesia machine/ventilator, anesthesia cart, difficult airway cart, monophasic defibrillator, fully-functioning operating table, plasma screen television, six recording cameras, real laparoscopic towers, and two-way selective audio feed and recording. Additionally, there is a teleconferencing classroom directly adjacent to the virtual OR, which can accommodate 55 individuals. This facility is fully equipped to broadcast training exercises internally from the virtual OR to the classroom or anywhere worldwide. This auditorium may also be used for debriefing sessions, as needed. The simulation center also has a skills lab equipped with tasks trainers for airway management and invasive line placement.

A Simulation Lab in L3.213, built in 2006 and equipped with two Meti mannequins and a Laerdol Sim Baby, this 450 square foot facility hosts simulation events for medical students and residents from internal medicine, emergency medicine, pediatric emergency medicine, and surgery. Other users include University Hospital nurses, Parkland emergency medicine physicians, and high school students in the Science Teacher Access to Resources at Southwestern program.

An Emergency Medicine Clinical Skills Lab in the basement of the Chase Bank building on the North campus. Ten clinical skills rooms, amounting to approximately 1200 sf are part of the EMT and paramedic education. Students are enrolled in El Centro College, and UT Southwestern has a contract with El Centro to teach the courses.

Children's Medical Center Simulation Lab is a 3000 sq. ft. facility opened in fall of 2009; it is located on the 6th floor of the pavilion ambulatory center. It features high fidelity mannequins (3 SimBaby, 1 SimMan, 1 SimMan3G, 1 NeoHal [NICU], Pediasim [child]) and medium fidelity mannequins (Megacode Kelly, 2 Megacode child, 1 Megacode baby). There are also a large number of task trainers, like models for placement of central lines, chest tubes, foley, and IV's; as well as performance of arterial sticks and LP's. The lab is also used by CMC staff for team training.

The William P. Clements, Jr. University Hospital Simulation Labs became available in last month. These include two ICU rooms paired with two debriefing rooms in the MICU area and a simulation suite in the neonatal ICU.

A Standardized Patient Lab in L3.228, five rooms built in 1992 and a sixth added in 2003, represent the oldest clinical skills facility on campus. They are equipped with digital cameras, microphones, and local recording equipment. Users include medical and physician assistant students, who keep the facility busy throughout the year. The center boasts a cadre of almost 100 standardized patients, some of whom have decades of experience in this role.

Upcoming Developments

B-Line and Standardized Patients

A state-of-the-art clinical skills center is being built to host our already robust standardized patient program. The cameras, microphones, and supporting hardware will be upgraded and placed on a computer network so trainees and their instructors can easily access the digital recordings. Instructors will be able to add data by annotating these digital video recordings for review by the trainees. The entire databank will be stored for the tenure of the student to help document progression of skills and potentially be used for e-portfolios.

West Campus Phase I

Approximately 50,000 total square footage of the first new West Campus building will be allocated to the simulation center. It is likely to contain a 20 exam room standardized patient suite, four large rooms equipped with simulators to serve as mock operating rooms, emergency suites, labor and delivery suites, and intensive care units. There will likely be dedicated space for trainees to access task trainers for deliberate practice at times most convenient for the trainees.

Enterprise Data Warehouse – Dashboards for Education?

The campus has already developed sophisticated analytics for clinical care. The campus leadership is now turning their attention to the other missions of the campus, including education. The vision is to create an "Enterprise Data Warehouse" to serve as a repository for performance data from various systems; this will then be used to create analytics for the purpose of an easily accessed and understood, real-time monitoring of the missions of the school.

Epilogue

With the advent of technology come risks and benefits. Aldous Huxley warned us of a mindless future caused by technology. George Orwell warned us of a future of technology supporting a culture of suspicion and autocracy. In the world of medical education, the best synthesis of the ideal future found by the author is as follows.

> *"… technology should not be used to further distance trainees from the front lines of health care … thoughtful use of technology can enable future physicians to utilize Watson in order to better practice medicine in the spirit of Osler."[48]*

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