

Beyond See-One, Do-One, Teach-One: Applying HF to Clinical Training and Education

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While HF is enjoying a growing profile within the medical community, the role of HF with respect to clinical training and education in particular has not been clearly defined. The purpose of this panel is to explore the intersection of HF and clinical training, and to delineate some of the opportunities and challenges that exist. The panel will discuss a number of current examples of how HF techniques are being applied to develop and implement clinical education initiatives.

INTRODUCTION

The extremely dynamic nature of healthcare makes training and education vital elements of developing and maintaining high levels of performance. Demands for training arise from a variety of sources, including the education of new practitioners, the introduction of new equipment and technology, and the development of new techniques and procedures. The recent focus on safety in healthcare (e.g., Kohn et al., 2000) has also inspired a broad range of process improvement initiatives, many of which involve a strong training/education component.

The purpose of this panel is to explore how HF can contribute to the definition and implementation of training and education for the clinical environment. While medicine has been quick to incorporate some training concepts with roots in HF (e.g., the use of simulation to teach

variants of crew resource management; Howard et al., 1992), there are many potential application areas that HF has yet to penetrate. The panel will discuss examples of how HF techniques have been leveraged in developing and deploying healthcare training, and will explore further opportunities for HF to make an impact in this area.

Procedural Skills Training

One example of an area where HF may have a significant role to play is in the training of procedural skills, particularly for new trainees. Healthcare is relatively unique among risk-prone industries in the degree to which technical work is routinely assigned to relative novices (i.e., students, interns, and junior residents). The apprenticeship model of training procedural skills (as referred to by the somewhat apocryphal “see-one, do-one, teach-one” adage) has been viewed as an imperfect but

necessary way to provide practitioners with the experiences required to become competent.

It is however recognized that this may at times expose patients to a degree of additional risk due to the inexperience of the learning practitioner (e.g., Khuri et al., 2001). To patients, this is perhaps most salient in the case of invasive procedural skills, although it is worth noting the idea is no less applicable to skills such as teamwork, communication, and the various strategies, heuristics and “know-how” that support proficient performance across the spectrum of patient care activities.

One path to minimizing these risks for procedural skills involves requiring trainees to demonstrate a certain level of competence before having contact with patients. Current models of expert performance (e.g., Ericsson, 2004) stress the role of repeated, deliberate practice in acquiring and maintaining expertise. But how can this principle be judiciously applied in clinical settings?

For any given procedure, this raises a number of questions. First, what separates novice performance from expert performance? What are the key component skills and which of these can benefit from off-line practice? What is the knowledge required to support these skills? What are the most effective ways to deliver the training? How should performance be measured? How do you provide feedback to learners? What standard do trainees need to perform to before being deemed “competent”? Many of these questions are familiar to the HF community and suggest that HF practitioners may have much to offer in developing skills training for healthcare settings.

Evolving Equipment, Techniques, and Processes

Training needs also arise from the rapid pace of development in medical equipment and technology. Problems related to human-machine interaction with computerized medical devices are well documented (e.g., Cook and Woods, 1996). While efforts by manufacturers to improve design and by hospitals to select more ergonomically sound equipment are part of the solution, even well-designed devices can require substantial training.

In addition to educating new practitioners, needs for training procedural skills also arise from developments in procedural techniques, which are frequently accompanied by new technologies. For example, the growing use of imaging technologies to assist in various invasive procedures has offered the potential for improved effectiveness, but has also transformed the skill sets required (see e.g., Sites et al., 2004).

The current public focus on safety in healthcare has also served to highlight the importance of ongoing training as a way to improve and maintain performance, even for experienced practitioners. The recognition of team coordination and communication as fundamental skills impacting safety has led to widespread efforts to incorporate these skills in training curricula, particularly through simulation.

Evolving Educational Technologies

The range of educational technologies and techniques available to medical educators has grown considerably in recent years, but the task of matching technologies to needs appropriately remains far from trivial. For example, while full-scope simulation offers the opportunity for realistic, situated training without risk to patients, it is accompanied by a number of significant challenges. Establishing and running a simulation facility is expensive in terms of both time and resources. Although patient simulators are becoming increasingly advanced, they are often still far from fully realistic and represent a limited range of patient anatomy, physiology and interaction. Full-scope task training also runs the risk of emphasizing the whole at the expense of the parts – i.e., trainees may improve timesharing and communication skills but get relatively little practice at component technical skills.

How can HF bring more rigor to the use of these methods? As healthcare educators continue to adopt new technologies and methods (e.g., virtual reality training, web-based education, part-task and full-scope simulation), what does HF have to teach the healthcare community about how these technologies can be deployed effectively?

Practical Challenges for Applying HF to Clinical Training and Education

Despite the commonalities with other domains where HF is more established, the healthcare environment uniquely emphasizes certain practical challenges that investigators must confront. For example, performing observations of actual care settings raises issues of privacy, both for patients and providers. The risks of creating data and analyses that may be subject to legal discovery in malpractice claims must be considered.

Apart from legal considerations, practitioners may be understandably reticent when asked to participate in studies of how their performance impacts safety. Physicians in particular have a relatively high degree of both status and autonomy, making it important for the HF researcher to be able to build a relationship of trust with participants. Close collaboration with a physician partner is often needed to facilitate access, establish credibility, and seek funding, in addition to helping understand technical aspects of the domain.

Delivery of training in clinical settings also raises practical issues. For example, while simulation and related techniques continue to gain traction in healthcare, the already high training burden on new practitioners means that it is not feasible to simply continue adding to existing curricula. Models that allow streamlining or replacing existing requirements are also required.

PANELIST ABSTRACTS

The panel members' topics represent a cross-section of perspectives and techniques for bringing HF to bear on issues related to defining and implementing effective clinical training and education. Medicine has been relatively proactive in adopting and applying concepts and techniques from HF, as exemplified by the two physician members of the panel (Mackenzie, Blike). Three of the panelists (Cao, Guerlain, Blike) address training in the context of specific procedural skills, while the others examine issues that have relevance across individual procedures. Some (Patterson, Mackenzie, Blike) focus on how training needs are identified,

while others focus on understanding the most effective ways to deliver training materials in the clinical environment.

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"Stacking" is a universal strategy displayed by experienced registered nurses (RNs) to dynamically manage the "to-be-done" tasks in order to deliver safe and effective care. The role of RNs goes beyond directly providing care to a patient. Essential is integration and coordination of patient care and patient care flow across multiple team members. Compared with novices, experienced RNs are much more adept at delivering safe care through continuous prioritizing and reprioritizing of care delivery goals and timelines, adjusting desired goal outcomes, and abandoning some goals when necessary. Given the increasingly higher acuity of patients and complexity of healthcare systems, decisions regarding organization and prioritization are critical features of RN work and affect patient safety and quality of care. Study findings have implications for educational programs and support software for RNs across multiple healthcare settings in order to more quickly achieve "stacking" proficiency.

Caroline G. L. Cao, PhD
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Many endoscopic training simulators exist and have been shown to improve surgeons' performance in the OR. The incorporation of these simulators into the surgical training curriculum to maximize learning has not been examined, such as whether trainees receive adequate feedback from the simulator. We studied the effects of feedback, or Knowledge of Results (KR; i.e., performance outcome) on the learning curve of laparoscopic intracorporeal suturing and knot tying in the ProMIS laparoscopic simulator. Nine medical students with no previous laparoscopic surgical

experience were divided into three different groups, each with different levels of knowledge of results. Each subject attended a training session for 1 hour each day, 6 days a week for 4 consecutive weeks. Group 1 (No feedback) received no knowledge of results (KR) and no performance feedback. Group 2 (feedback only) received factual KR following each training session, but no coaching. Group 3 (feedback and coaching) received KR and coaching throughout each session. Learning curves were plotted based on task time, smoothness of instrument movement and instrument path length. Perceived workload for each session was assessed using a standardized NASA-TLX workload score. Results showed that Groups 2 and 3 learned significantly faster than those in Group 1, reaching performance plateaus with fewer training sessions. There were no significant performance differences between groups 2 and 3. Providing individuals with knowledge of results lowered their perceived workload, while adding instructional feedback lowered this even further. These results demonstrate that KR is essential for efficient surgical skill acquisition. Individual coaching, a labour-intensive proposition, reduces perceived workload but has little added beneficial effect on the speed of learning. These results provide a useful basis for developing efficient and cost effective surgical skills training curriculum.

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Previous studies show strong evidence for a learning curve taking place during the first set of laparoscopic cases performed by a surgeon. We thus developed an anatomy recognition training intervention, specifically the use of an ordered set of video clips that show the main steps of a laparoscopic procedure several times in succession, with each repetition coming from a different surgery. A factorial designed experiment with 30 medical students showed that this training methodology significantly increased subjects' perceptual and procedural knowledge, with no corresponding increase for the control group who

watched the videos from the same cases but in an unstructured format for the same amount of time ($p < .05$). The study suggests an approach to training perceptual and procedural knowledge in an effective, safe and efficient manner, serving as a complement to other types of offline training methods that teach physical dexterity, strategic and declarative knowledge.

Jacob Seagull, PhD

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In many current patient safety initiatives, educational efforts often stress issues related to compliance to procedures, rather than conveying novel information to care providers. This emphasis may be present in initiatives such as those to encourage handwashing, reduce hospital acquired infections, prevent patient falls, and encourage adherence to identity-checking policy. Education for motivation-based programs may require non-traditional pedagogical techniques in order to be effective. Video vignettes have been shown to be one such effective technique. Video recordings of real patient care that shows common "mistakes" made by providers can serve as a powerful motivation tool. Video can demonstrate, in a real care-provision setting, the repercussions of care-provider failures to follow safety protocols. Use of such video must address privacy issues and safeguard patient confidentiality. Development and deployment of a training program to increase compliance to aseptic techniques for central venous catheterization exemplifies many of the challenges, and will be discussed.

Colin Mackenzie, MD

Professor of Anesthesiology

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To reduce critical error rates in the airline industry, computerized prompts are built into flight-control systems providing immediate feedback and

error avoidance. This work describes the challenges of such an approach in healthcare. Decision algorithms for trauma patient resuscitation encourage consistency, reduce error rates and significantly reduce resuscitation time. Even when experienced clinicians are involved, communication of significant clinical decisions fails 50% of the time. We describe how linking computer generated prompts via visual and auditory displays within the resuscitation bay should enhance clinicians' interaction and reduce errors. Evaluation can use patient chart review, but we describe an approach to measure the process of care by video recording. It identifies the key process problems in trauma management (errors of omission, commission and mis-prioritization) and provides a framework for learning and feedback.

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The objective of the study to be discussed was to characterize the behavior of novices learning to perform ultrasound-guided peripheral nerve blocks. Ultrasound-guided peripheral regional anesthesia is a new practice with limited literature examining strategies of how to train practitioners to become competent. In a preliminary study we found that ultrasound novices make repeatable errors which could result in iatrogenic injuries. The current study was therefore undertaken as part of an effort to develop and validate a compact and comprehensive program that trains the ultrasound novice prior to any contact with real patients. Six novices were studied. Every block performed during a one month period was video-taped and analysed with an expert critiquing technique. Both qualitative and quantitative metrics of performance were codified by two reviewers. We observed both known, and previously unknown patterns of errors. These data will inform subsequent design and development of targeted training interventions to minimize patient exposure to the risks associated with learning-curve error.

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