Simulator Training For Vascular Access Interventions

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Notes

Dialysis access placement and maintenance require a complex coordination of people, systems, and technology. When functioning correctly the system optimizes outcomes, including improved safety with fewer complications, decreased costs, timely and accurate diagnosis and treatment decisions. Also, patient and workers experience enhanced satisfaction.

High risk industries, most recognized in the airline industry, have utilized the safety benefits from specific training aimed to improve interactions between humans and systems. These concepts must be taught and understood and continuously, updated and refined if optimal outcomes are to be expected. Implementation of human - system interactions involve change in the institutional culture. Change in this respect in the care of End Stage Renal Disease and the dialysis access placement should induce significant outcome improvement. Effective complex systems emphasize three essential concepts: First, making systems and technology "user-friendly" in order for people to use them to enhance performance. Second, people must work and train together as a team and not act independently. This requires a culture change defined by the term ***interdependent thinking***. Third, in complex systems the team of people assigned to use the system must practice and test the system ***before*** using them on patients.

Traditionally, healthcare learning, training, and testing takes place in unrealistic classroom settings, emphasizing knowledge based learning, ignoring the environment where the actual technology is implemented. These methods use target teaching of the individual away from the system in which he or she will be functioning. This means that the function of healthcare systems is never fully tested until a patient is involved. Imagine being a passenger if the airline industry functioned the same way! In fact, we in medicine have much to gain from aviation's past hard learned lessons (1). Almost everyone agrees with the concept of "doing better" i.e. quality improvement. There is much written, including workshop syllabuses for courses on a variety of related improvement strategies, usually by institutional mandates (2). There are courses for improving leaders personal communication skills (3). Many universities now teach credit courses in "Conflict Resolution Techniques".

Recent research suggests that current methods of quality improvement efforts may not be effective in the evolving and increasingly technological medical specialties (2). Dialysis access in ESRD patients represents one example of this inadequate quality approach. Why some people, some institutions and societies and their projects are more successful than others was not well understood, until 2007, when the Nobel Prize in Economic Sciences was awarded to Hurwicz, Maskin, and Myerson. They shed light on success in businesses, stating that ***"The (our) best intentions for public good will go astray if the Institutional Arrangements are not consistent with the personal self-interests of the decision makers".*** These complex people relationships are more likely to be subliminally present in large organizations, such as state and government institution (4).The fact that various members of the dialysis access delivery team are trained in isolation from each other exacerbates the detachment between the ESRD delivery system and the individual professional. Therefore, faced with an actual dialysis access emergency i.e. bleeding or other unexpected adverse outcome, the disconnected team response is unpredictable and an optimal outcome is unlikely.

There are three important undesirable results of dialysis access education being focused on the individual. First, it is impossible to anticipate or understand the impact of technology, protocols, or administrative decisions on the healthcare delivery system. ESRD and healthcare governing bodies interactions, decisions, mandates and implementations are complex and cannot be accurately predicted when evaluated in isolation or in unrealistic settings (if they are evaluated at all before being implemented!). Second, by targeting the individual, the system tends to blame this individual for any adverse outcome, as opposed to improving safety in the system (5). The loss of alignment between the individual, technology and the healthcare delivery system as a whole have not been adequately considered, reflected in the unrelenting growth of medical malpractice of the individual, usually the doctor. The current culture assumes that

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underlying medical malpractice that ***"someone did something wrong and has to be responsible."*** Third, without being able to simulate the healthcare delivery system in a realistic setting, trying to identify weaknesses and implement improvements is hazardous and impossible.

The result is that the governing bodies try to improve outcomes by imposing regulations through protocols that have become increasingly complex. Protocols, although developed with the best intent, are never tested in a realistic environment and are, therefore, impossible to confirm as effective. Finally, the development of dialysis access protocols serves one purpose: define what the individual is supposed to do usually without regard to practicality and always without considering the interactions of the entire system and the patient. This makes the "blame the individual" response to poor healthcare outcomes unavoidable (5). Then, the current system of healthcare training and testing perpetuates the concept that outcomes rely upon the individual as opposed to the system. Fear of failure and of reprisal for adverse outcomes is supported by this design and, therefore, the individual is dissuaded from identifying areas of healthcare system weakness and suggesting improvements. In the current system, suggestions for improvement (usually in the form of "incident reports") result in finding someone to blame, the unavoidable consequence of the existing, individual focused system. To significantly improve the outcomes of the healthcare system, fundamental change in the education, training, and testing process must occur. (5, 6)

The most important change needed is to move from focusing solely on the individual to emphasizing the individual's interaction with the entire ESRD and Dialysis Access system. This does not decrease or eliminate the individual's responsibility. In fact, it expects each stakeholders to also consider and take into account other team-members, experience and expertise. The overall public good must prevail over the individual goals. However, this is a subject so complex that it took a Nobel Prize in Economic Sciences 2007, only to solve from a theoretical aspect. (7,8)

Dialysis Access Simulation Training

For logistical (economic) reasons, a simulated dialysis access training environment is an integral part of larger healthcare training facilities, allowing for the teaching, training, testing and certification of every member of the dialysis access team in existing paradigms of care and procedures, and for the development of new care paradigms, new procedures, and new technology and devices before being applied to patients. The dialysis access simulation training is designed so that participants will "dispel disbelief" by producing realistic, reproducible situations, that directly translate to the actual dialysis access environment, such as the complete operating room or interventional suite with all team members present in their real role. The simulation center allows users to refine their skills, to identify potential problems, and to observe the outcomes produced in a realistic setting, including an emergency room, outpatient office, the operating room, and interventional radiology suites. The Dialysis access Training staff includes representatives of all areas of the dialysis access team and experts in curriculum development. The dialysis access training curriculum includes customized (multi-level) curricula targeting distinct personnel categories as well as the entire team together. The Simulated environment is designed to encourage participants to "dispel disbelief", and function exactly as in actual healthcare delivery environment, with state-of-the-art computer-controlled patient simulator mannequins and virtual equipment to enhance experience

The three basic components in dialysis access training are: **1. Knowledge,** as an "on line" extensive reading material available including ESRD background information, patient selection algorithms and indication for the mode, type and anatomic site, and describing dialysis access procedures by written text and images. **2. Skills Training,** includes concentrated short classroom learning with PP and video clips, testing and hands on learning under direct supervision in a simulation environment **3. Social Intelligence** (SI) training, in aviation referred to Crew resource (CRM) of Human Factor (HF). These integrated training sessions will motivate the participants align to a team effort, setting self aside and working for the public (patient)

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good adopting an interdependent mindset. Patient and family actors are used when appropriate. Every simulation area is computer controlled with voice, video and data recording. Post-simulation debriefing includes review of the simulation (edited or actual time). Such simulation examples and best practices can be delivered worldwide in person or by the Internet. The dialysis access simulation supports the "train the trainer" concept, meaning that dialysis access expertise can be developed in the simulation center. Subsequently, team training at the local level can take place using skills, techniques, and experiences taught at the center, reinforced and supported by the simulation center staff.

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Areas of Current and future *Dialysis Access Simulation* development

1. Computerized interventional radiology simulator.

Training in percutaneous catheter-based procedures has become fragmented and variable in quality, largely due to the heterogeneity of proceduralists who carry out these procedures. For example, a given procedure (such as venous angioplasty) may be performed by a surgeon, interventional nephrologist, or interventional radiologist. Given that each specialist has trained differently and garnered a different set of core competencies and skills, there may be wide variations in judgment and technique. Simulation of venous angioplasty, however, can provide a level of standardization in training, as well as metrics to assess judgment and technique. Ultimately, the experience on a simulator, coupled with end-of-case metrics that highlight strengths and weaknesses, can promote consistency and shift the physician to a higher level of competency. A number of simulators have been developed for arterial intervention, such as aortic endograft simulators. These simulators recreate the feel (haptics), visual fluoroscopic images, cardiovascular monitoring, and the procedural environment that a physician experiences during endovascular procedures. With appropriate proctoring and feedback during a series of endograft deployments, endovascular physicians can acquire skills leading toward safe and effective clinical use of aortic endo-grafts in patients. Today, most certification pathways for use of proprietary aortic endo-grafts require simulator training. Arteriovenous hemodialysis access simulators are now being developed for catheter-based procedures, and the first such simulator is slated for release at the end of 2010.

2. Defined Simulation Based Training protocols for learning Ultrasound guided cannulation

Ultrasound use for central vein vascular cannulation in dialysis access is of paramount importance (9) Standardized training and experience is often lacking. ***The ultrasound guided procedures teaching*** emphasis integration of three new attitudes: First, understanding the echo-graphic anatomy and image interpretation including artifacts. Second, the trainee must develop confidence in image-mediated rather than eye-guided hand-probe motions and coordination between the hands moving in different directions, where the non-dominant hand directs the probe and the dominant hand performs the invasive procedure. Third, the trainee must attain confidence in handling the insertion device and tools, their part and how to assemble.

We have developed a strict, standardized Ultrasound-guided inexpensive home-made simulator for cannulation of large veins as well as of dialysis access grafts and fistulas. The simulator consists of a turkey paw or breast with an appropriately placed rubber or PTFE tube, simulating the vein or the dialysis access. Each of the seven teaching steps presents tasks of increasing difficulty. US scanning and cannulation techniques are strictly standardized. This learning protocol allows for multiple attempts, i.e. learning by mistakes in a low stress environment. Currently the US training entails three stations: ***1. Live real time large (neck) and small (peripheral) vein US demonstration of vascular anatomy for cannulation. 2. Large vein needle cannulation using the Seven step teaching. 3. Dialysis access US directed cannulation training with a large 6-7 mm tube tunneled 3-5 mm below the turkey skin surface in a pressurized system filled with a red blood simulation fluid.***

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Conclusions

Simulation is the mainstay for training for dialysis access systems before applied to patients. The dialysis access training curriculum includes evaluation, testing and training of dialysis access delivery in a realistic manner, considering the entire ESRD system and all team members. The emphasis of the simulation is to improve measurable outcomes with a focus on safety, and patient and access survival.

Notes

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