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Chapter 1 : Pilot Simulator Training Isn't Enough | BCA content from Aviation Week

Brought to you by VirTra. How simulators will transform police use of force training in As use of force simulator tech continues to become further validated with science-based research.

This article has been cited by other articles in PMC. Abstract Simulation is a technique for practice and learning that can be applied to many different disciplines and trainees. Simulation-based medical education can be a platform which provides a valuable tool in learning to mitigate ethical tensions and resolve practical dilemmas. Simulation-based training techniques, tools, and strategies can be applied in designing structured learning experiences, as well as be used as a measurement tool linked to targeted teamwork competencies and learning objectives. It has been widely applied in fields such aviation and the military. In medicine, simulation offers good scope for training of interdisciplinary medical teams. The realistic scenarios and equipment allows for retraining and practice till one can master the procedure or skill. An increasing number of health care institutions and medical schools are now turning to simulation-based learning. Teamwork training conducted in the simulated environment may offer an additive benefit to the traditional didactic instruction, enhance performance, and possibly also help reduce errors. These two competing needs can sometimes pose a dilemma in medical education. Also, medicine is a discipline that is a science as well as an art and repeated exposures with enhanced experience will help improve skills and confidence. Doctors have to be good team players and their training programmes must systematically inculcate these skills. In the s, during the time when personal computers became less expensive and more simulation software became available, independent groups began to develop simulator systems. Much of this was utilized in the areas of aviation, military training, nuclear power generation, and space flights. In the early s, more comprehensive anesthesia simulation environments were produced, which included the MedSim and, later, the Medical Education Technologies Inc. Aviation simulation training concepts then begun to be gradually introduced into anesthesia and other areas of medicine like critical care, obstetrics, emergency medicine, and internal medicine. Current full-body simulator models incorporate computerized models that closely approximate the physiology seen in the human body. Simulation-based medical education can be a platform for learning to mitigate ethical tensions and resolve practical dilemmas. Simulationbased training techniques, tools, and strategies can be applied in designing structured learning experiences, as well as be used as a measurement tool linked to targeted teamwork competencies and learning objectives. Simulation-based learning itself is not new. It has been applied widely in the aviation industry also known as CRM or crew resource management , anesthesiology, as well as in the military. It helps to mitigate errors and maintain a culture of safety, especially in these industries where there is zero tolerance for any deviation from set standards. Medical, nursing, and other health care staff also have the opportunity to develop and refine their skills, repeatedly if necessary, using simulation technology without putting patients at risk. In both aviation and health care domains, human performance is strongly influenced by the situational context, i. In aviation, more than 50 years of research has shown that superior cognitive and technical skills are not enough to ensure safety: Similar observations are also now being made in the practice of medicine. It has indeed turned out to be a very flexible and durable form of medical education and training. Much of the cost is contributed to by the manpower or technician costs as well as cost of the laboratory setup and maintenance. The computer- and information technologycontrolled equipment advances medical learning and ensures that students and doctors learn procedures and treatment protocols before performing them on actual patients. The simulated environment allows learning and re-learning as often as required to correct mistakes, allowing the trainee to perfect steps and fine-tune skills to optimize clinical outcomes. The simulated situation and scenarios can give students and inexperienced junior doctors realistic exposure to such cases. It can certainly help in making books and lecture materials come alive. It helps ensure that students and trainees gain clinical experience without having to depend on chance encounters of certain cases. Many also believe that simulation-based learning enhances efficiency of the learning process in a controlled and safe environment. These are also being utilized to assess candidates in the objective structured clinical examination OSCE. Technical and functional expertise training Problem-solving and decision-making skills Interpersonal and communications skills or team-based competencies All of these share a common thread in that they require active listening and collaboration besides possession of the basic knowledge and skills. With every training programme it is best to have feedback and debriefing sessions that follow. Feedback must be linked to learning outcomes and there must be effective debriefing protocols following all simulation exercises. Studies have shown that simulation improves learning. Multidisciplinary teams deliver a multitude of health care services today but many organizations still remain focused on individual technical responsibilities, leaving practitioners inadequately prepared to enter complex team-based settings. When health care providers of different disciplines train separately, it may be difficult to integrate their capabilities. Effective multidisciplinary teams must always have good communications and leadershipsharing behavior, which can help ensure patient safety. Inculcation of teamwork values is an example of the nontechnical, but essential, part of training of medical professionals. Simulation has the potential to create lasting and sustainable behavior and culture change that will make health care more effective and safer. Transformational change can only come about when the learner recognizes the problems and then adopts a proactive approach to work on it and correct it. The essence of a team is the shared goal and commitment. It represents a powerful unit of collective performance, which can be done as an individual or mutually. These must eventually translate common purpose into specific performance goals. One of the important ingredients of teams with good outcomes is the basic discipline of the team. Simulation training and practice affords the essentials for creating an effective medical team with a sense of group identity, group efficacy, and trust amongst members. There needs to be true engagement and understanding for team members to work together well. Examples of these can be seen in the incredible teamwork and excellent team dynamics that can exist during good resuscitation, certain surgery, and the more complex intensive care cases. Members who have had sufficient training and knowledge can be flexible enough to adapt to any new situation and break out of their ingrained routines and they get more proficient with time. A learning team will have some degree of substitution, defined roles and responsibilities, flexibility, good process flow, and an awareness of common goals. Conflict resolution is another aspect of teamwork that can be practiced during simulations. Medical staff reported that error is an important issue but difficult to discuss and that it was not being handled well in their hospital. The composition varies according to the objective of the teams; examples include stroke management teams, trauma teams, acute coronary syndrome intervention teams, etc. The training of each member of the team is decided by his or her own discipline. As such, there is a need to bring them together in an integrated fashion to learn how to manage a patient with complex medical problems. No one discipline is more important than the other. Everyone has a role to play. There must also be some flexibility allowed at various junctures of decision-making and intervention. Team-work skills and interpersonal communication techniques are essential components of such training and exercise. They must be able to objectively view the group dynamics and interaction within the teams they train and provide valuable feedback. Videotaping the role-playing is useful as it can be played back and the highlights shared with the team as part of their learning process. Trainers can points out both the negative and positive practices and behaviors to the participants. These writers can customize the scenarios for interdisciplinary team training and role-playing in order to highlight or facilitate certain roles or team interaction. These scenarios should be realistic, practical, and comprehensive. Scenarios would usually also have event triggers, environmental distractors, and supporting events. They should be developed systematically with proficiency-based assessment in place, which can emphasize integrative team performance as well as technical performance. All practice and action should also be validated by data and evidence. The absence of clearly defined specified roles may persist, despite generally acceptable team performance; this may not become obvious until there is a change in team members, which then reveals the role confusion. Most health care systems have no or few processes or backup plans when errors occur. However, there is no method to measure this. It can be used for undergraduate training such as in the study of anatomy, physiological functions, familiarization with medical examination techniques , for residency training e. It must include adequate space for training small groups, rooms with one-way mirrors, and sufficient space for equipment setup, amongst other facilities. There must also be provision for video recording equipment. Manpower would include full-time technicians and a manager; the trainers are usually part-time medical personnel. The decision to purchase suitable mannequins and equipment must only be made after adequate demonstration and trials have been done and all parties are satisfied. It is also important to have technical support from the vendors in the long term. The different forms of medical simulation technology training that can be considered for the center would include: The centerpiece is usually a fullsized patient simulator that blinks, breathes, and has heart beat, pulse, and respiratory sounds. This mannequin can be very technologically advanced. This simulator can be used for scenarios from simple physical examination to interdisciplinary major trauma management. Some simulators can even recognize injected medications via a laser bar-code reader and then respond with appropriate vital sign changes Simulated clinical environment: An intensive care unit, emergency room cubicle, or operating room is prepared with all the equipment and the crash cart. The setup is as realistic as the actual facility. Trainees can familiarize themselves with the setup and arrangements. Various stations can be set up, depending on what the focus is. These stations will have all the relevant equipment and setup for the procedure to be carried out, e. As more health care institutions adopt electronic medical records to track and to manage patients, this can also be a station setup in the center. The system utilized will have fictitious patients with their histories, notes, and lab results. There may also be system integration, such as the link between records and the laboratory as well as the radiology results digitalized radiographs. Currently, adult simulation equipment and mannequins are already well established. Pediatric ones are still in the experimental stage, but there will be future developments. For institutions that cannot afford to set up an entire simulation laboratory, a less expensive option could be to invest in simulation mannequins only. This could be purchased in different numbers and be used for training purposes. Institutions and their leaders must learn to accept the candidates with an open mind. The leaders must be strict with their education and training portions.

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Chapter 2 : Simulation - Wikipedia

If the military can use simulators as a cost-effective way to train pilots so can all other training facilities including universities. In fact, it is possible for all pilots, including those wanting to study from home, to use flight simulators to their advantage.

Visualization of a direct numerical simulation model. Historically, simulations used in different fields developed largely independently, but 20th century studies of systems theory and cybernetics combined with spreading use of computers across all those fields have led to some unification and a more systematic view of the concept. Physical simulation refers to simulation in which physical objects are substituted for the real thing some circles [4] use the term for computer simulations modelling selected laws of physics , but this article does not. These physical objects are often chosen because they are smaller or cheaper than the actual object or system. Interactive simulation is a special kind of physical simulation, often referred to as a human in the loop simulation, in which physical simulations include human operators, such as in a flight simulator or a driving simulator. Continuous simulation is a simulation where time evolves continuously based on numerical integration of Differential Equations. Hybrid Simulation sometime Combined Simulation corresponds to a mix between Continuous and Discrete Event Simulation and results in integrating numerically the differential equations between two sequential events to reduce number of discontinuities [7] Stand Alone Simulation is a Simulation running on a single workstation by itself. Fidelity is broadly classified as 1 of 3 categories: Specific descriptions of fidelity levels are subject to interpretation but the following generalization can be made: Low â€" the minimum simulation required for a system to respond to accept inputs and provide outputs Medium â€" responds automatically to stimuli, with limited accuracy High â€" nearly indistinguishable or as close as possible to the real system Human in the loop simulations can include a computer simulation as a so-called synthetic environment. This was the best and fastest method to identify the failure cause. Computer simulation A computer simulation or "sim" is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works. By changing variables in the simulation, predictions may be made about the behaviour of the system. It is a tool to virtually investigate the behaviour of the system under study. A good example of the usefulness of using computers to simulate can be found in the field of network traffic simulation. In such simulations, the model behaviour will change each simulation according to the set of initial parameters assumed for the environment. Traditionally, the formal modeling of systems has been via a mathematical model , which attempts to find analytical solutions enabling the prediction of the behaviour of the system from a set of parameters and initial conditions. Computer simulation is often used as an adjunct to, or substitution for, modeling systems for which simple closed form analytic solutions are not possible. There are many different types of computer simulation, the common feature they all share is the attempt to generate a sample of representative scenarios for a model in which a complete enumeration of all possible states would be prohibitive or impossible. Several software packages exist for running computer-based simulation modeling e. Monte Carlo simulation, stochastic modeling , multimethod modeling that makes all the modeling almost effortless. Modern usage of the term "computer simulation" may encompass virtually any computer-based representation. Computer science[edit] In computer science , simulation has some specialized meanings: Alan Turing used the term "simulation" to refer to what happens when a universal machine executes a state transition table in modern terminology, a computer runs a program that describes the state transitions, inputs and outputs of a subject discrete-state machine. Accordingly, in theoretical computer science the term simulation is a relation between state transition systems , useful in the study of operational semantics. Less theoretically, an interesting application of computer simulation is to simulate computers using computers. In computer architecture , a type of simulator, typically called an emulator , is often used to execute a program that has to run on some inconvenient type of computer for example, a newly designed computer that has not yet been built or an obsolete computer that is no longer available , or in a tightly controlled testing environment see Computer architecture simulator and Platform virtualization. For example, simulators have been used to debug a microprogram or sometimes commercial application programs, before the program is downloaded to the target machine. Simulators may also be used to interpret fault trees , or test VLSI logic designs before they are constructed. Symbolic simulation uses variables to stand for unknown values. In the field of optimization , simulations of physical processes are often used in conjunction with evolutionary computation to optimize control strategies. Simulation in education and training[edit] Main article: Adaptive educational hypermedia Simulation is extensively used for educational purposes. It is frequently used by way of adaptive hypermedia. Simulation is often used in the training of civilian and military personnel. In such situations they will spend time learning valuable lessons in a "safe" virtual environment yet living a lifelike experience or at least it is the goal. Often the convenience is to permit mistakes during training for a safety-critical system. There is a distinction, though, between simulations used for training and Instructional simulation. Training simulations typically come in one of three categories: Constructive simulation is often referred to as "wargaming" since it bears some resemblance to table-top war games in which players command armies of soldiers and equipment that move around a board. In standardized tests , "live" simulations are sometimes called "high-fidelity", producing "samples of likely performance", as opposed to "low-fidelity", "pencil-and-paper" simulations producing only "signs of possible performance", [18] but the distinction between high, moderate and low fidelity remains relative, depending on the context of a particular comparison. Simulations in education are somewhat like training simulations. They focus on specific tasks. Normally, a user can create some sort of construction within the microworld that will behave in a way consistent with the concepts being modeled. Seymour Papert was one of the first to advocate the value of microworlds, and the Logo programming environment developed by Papert is one of the most famous microworlds. As another example, the Global Challenge Award online STEM learning web site uses microworld simulations to teach science concepts related to global warming and the future of energy. Project Management Simulation is increasingly used to train students and professionals in the art and science of project management. Using simulation for project management training improves learning retention and enhances the learning process. These may, for example, take the form of civics simulations, in which participants assume roles in a simulated society, or international relations simulations in which participants engage in negotiations, alliance formation, trade, diplomacy, and the use of force. Such simulations might be based on fictitious political systems, or be based on current or historical events. This is also called a Social media stresstest. In recent years, there has been increasing use of social simulations for staff training in aid and development agencies. The Carana simulation, for example, was first developed by the United Nations Development Programme , and is now used in a very revised form by the World Bank for training staff to deal with fragile and conflict-affected countries. Specifically, virtual firearms ranges have become the norm in most military training processes and there is a significant amount of data to suggest this is a useful tool for armed professionals. Virtual simulations allow users to interact with a virtual world. Virtual worlds operate on platforms of integrated software and hardware components. In this manner, the system can accept input from the user e. There is a wide variety of input hardware available to accept user input for virtual simulations. The following list briefly describes several of them: For example, if a user physically turns their head, the motion would be captured by the simulation hardware in some way and translated to a corresponding shift in view within the simulation. The systems may have sensors incorporated inside them to sense movements of different body parts e. Alternatively, these systems may have exterior tracking devices or marks that can be detected by external ultrasound, optical receivers or electromagnetic sensors. Internal inertial sensors are also available on some systems. The units may transmit data either wirelessly or through cables. Eye trackers can also be used to detect eye movements so that the system can determine precisely where a user is looking at any given instant. Physical controllers provide input to the simulation only through direct manipulation by the user. In virtual simulations, tactile feedback from physical controllers is highly desirable in a number of simulation environments. High fidelity instrumentation such as instrument panels in virtual aircraft cockpits provides users with actual controls to raise the level of immersion. For example, pilots can use the actual global positioning system controls from the real device in a simulated cockpit to help them practice procedures with the actual device in the context of the integrated cockpit system. This form of interaction may be used either to interact with agents within the simulation e. Voice interaction presumably increases the level of immersion for the user. Users may use headsets with boom microphones, lapel microphones or the room may be equipped with strategically located microphones. Current research into user input systems[edit] Research in future input systems hold a great deal of promise for virtual simulations. Systems such as brainâ€”computer interfaces BCIs offer the ability to further increase the level of immersion for virtual simulation users. Using the BCI, the authors found that subjects were able to freely navigate the virtual environment with relatively minimal effort. It is possible that these types of systems will become standard input modalities in future virtual simulation systems. Virtual simulation output hardware[edit] There is a wide variety of output hardware available to deliver stimulus to users in virtual simulations. Visual displays provide the visual stimulus to the user. Stationary displays can vary from a conventional desktop display to degree wrap around screens to stereo three-dimensional screens. Wrap around screens are typically utilized in what is known as a cave automatic virtual environment CAVE. Stereo three-dimensional screens produce three-dimensional images either with or without special glassesâ€”depending on the design. Head-mounted displays HMDs have small displays that are mounted on headgear worn by the user. These systems are connected directly into the virtual simulation to provide the user with a more immersive experience. Weight, update rates and field of view are some of the key variables that differentiate HMDs. Naturally, heavier HMDs are undesirable as they cause fatigue over time. If the update rate is too slow, the system is unable to update the displays fast enough to correspond with a quick head turn by the user. Slower update rates tend to cause simulation sickness and disrupt the sense of immersion. Field of view or the angular extent of the world that is seen at a given moment field of view can vary from system to system and has been found to affect the users sense of immersion. Several different types of audio systems exist to help the user hear and localize sounds spatially. Special software can be used to produce 3D audio effects 3D audio to create the illusion that sound sources are placed within a defined three-dimensional space around the user. Stationary conventional speaker systems may be used provide dual or multi-channel surround sound. However, external speakers are not as effective as headphones in producing 3D audio effects. They also have the added advantages of masking real world noise and facilitate more effective 3D audio sound effects. These displays provide sense of touch to the user haptic technology. This type of output is sometimes referred to as force feedback. End effector displays can respond to users inputs with resistance and force. These displays provide a sense of motion to the user motion simulator. They often manifest as motion bases for virtual vehicle simulation such as driving simulators or flight simulators. Motion bases are fixed in place but use actuators to move the simulator in ways that can produce the sensations pitching, yawing or rolling.

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Chapter 3 : Simulation and training of choledochoscopy â€” Albert Einstein College of Medicine

Simulation-based training has been successful in other industries, such as aviation, and is emerging as a key component of the patient safety movement. Simulation is increasingly being used to improve clinical and teamwork skills in a variety of health care environments.

SOGREAH Port Revel Centre systems in the extent to which real-time interaction is facilitated, the perceived visual space is three-dimensional rather than two-dimensional, the human-machine interface is multimodal, and the operator is immersed in the computer generated environment. Such systems, although currently somewhat limited in capabilities, are progressing toward more complete simulations of visual environments and toward development of better simulations of sound and feel. If successful in achieving realistic training environments, some virtual environment technologies have the potential to reduce simulator costs. Other virtual environment technologies may increase costs, but they may also significantly extend simulator capabilities. At this time it is unclear which of the diverse features of virtual environments will enhance training effectiveness. A major research program funded by the U. Navy is currently exploring this issue. The goal of this program. Virtual Environment for Submarine Pilot Training, is to develop, demonstrate, and evaluate the training potential of a stand-alone virtual reality-based system for deck officer training and to integrate this system with existing submarine piloting and training simulators Hays, Page 51 Share Cite Suggested Citation: Current State of Practice. The National Academies Press. There is no research to determine whether or to what degree a realistic virtual environment simulation might be possible for the commercial marine operating environment. It also remains unclear whether enhanced technological capabilities of virtual environments will improve current levels of simulator effectiveness generally, and, if they do, whether use of these capabilities will be cost-effective. Given the state of the U. The results of research from other sectors might be adapted in the future. Initially, the method for using simulators in training was as an addition or complement to existing programs. Simulation enables creation of dynamic, real life situations in a controlled classroom environment where deck officers and pilots can: Simulators can also be used effectively to bring a new dynamic into the classroom by combining books and lectures with real-time simulator-based instruction to teach rather than just explain real operating skills. Although simulation can be a relatively low-cost option for training, use of simulation must be based on its suitability to training objectives. An expensive full-mission simulator for early instruction of navigation skills, for example, may be inappropriate if a less-expensive, limited-task simulator, or even interactive microcomputer-based instruction, would meet training objectives. A well-designed program of instruction will use a less-expensive, limited-task training device or interactive microcomputer-based system, designed to focus on specific tasks, rather than a full-mission device that is better suited for systematically integrating all performance components. The recent growth of all forms of marine simulators, and particularly ship-bridge simulators, is driven substantially by technology. Simulator facility operators have taken advantage of rapid advances in computer computational capabilities and Page 52 Share Cite Suggested Citation: Smaller, faster microcomputers with greater memory capacity have made it technically and financially practical to drive desktop simulators with complex hydrodynamic models at a reasonable cost. The latest advances in computational capabilities and software have permitted the addition of highly detailed visual scenes linked to full-motion platforms, providing a high level of apparent realism to marine simulators. However, whether these features achieve a sufficiently faithful reproduction of real-world effects, or add significant value to simulator-based training, has not been determined through either quantitative or qualitative assessments. Training can continue independent of adverse weather conditions, vessel operating schedules, and other training conditions e. The following sections discuss simulation characteristics as a teaching tool. Risks associated with training on operational equipment are a concern in any industry. Within the commercial air carrier industry, the widespread use of simulators in training has reduced training accidents. Simulators allow students to repeat a risky operation several times if needed. Unlike training on operational equipment, where an instructor must be prepared to intervene at all times, risky maneuvers can be safely practiced on a simulator. Simulation enables the placement of full responsibility on the prospective officer-of-the-watch before that individual actually assumes the duties of a licensed deck officer. Intervention, or even of such an intervention, can cause very significant differences among candidates for third mates in the level of confidence and ability to lead watchkeeping teams. In on-the-job training, concerns for safety of the vessel might cause an instructor to intervene earlier than is desirable for efficient progress of learning. During real operations, it may be necessary to interrupt training to avoid a real life accident. In simulator-based training, the instructor can allow students to make mistakes, to see the consequences, and possibly to practice recovery procedures. Although there is limited objective evidence on the value of permitting Page 53 Share Cite Suggested Citation: Using simulation, the instructor can terminate a training scenario as soon as its point has been made or repeat it until the lesson has been well learned. In contrast, opportunities for repetition are very limited during actual at-sea operations; the opportunity to repeat an exercise in on-the-job training aboard ship may not occur for weeks or months. Another feature of simulator-based training is the ability to record and play back the just-completed scenario for review, evaluation, and debriefing purposes. As a teaching tool, recording and playback empower the instructor to let mistakes and accidents happen for instructional emphasis and allow trainees to review their actions and their correct and incorrect decisions and experience the results of their performance after the exercise is completed. Simulator-based training permits systematic scheduling of instructional conditions as desired by the instructional staff or as directed in the training syllabus. Simulation permits the use of innovative instructional strategies that may speed learning, enhance retention, or build resistance to the normally disruptive effects of stress. Multiple Tasks and Prioritization. Deck officers at all levels of responsibility must continually decide at any given time, in any given situation, which among a number of tasks are most important. Use of simulation in training programs makes it possible to transfer classroom skills and to practice and prioritize multiple tasks simultaneously. Simulation training enhances development of skills and provides the opportunity to exercise judgment in prioritizing tasks. Training on New Technologies. By employing features such as the ability to repeat training exercises and to record and play back performance, simulators can provide a safe environment for training mariners in the use of new equipment. For some new equipment it is possible to place desktop simulators on board ships to provide an opportunity for independent training. Simulator-based training at simulator facilities can provide a forum for peer interactions and evaluations that might not otherwise occur. Because of the often solitary nature of their work, masters and pilots can routinely serve for years without having their work observed or critiqued by their Page 54 Share Cite Suggested Citation:

Chapter 4 : Simulation-based learning: Just like the real thing

through increased simulator use -3nd better training methods. More money has recently been spent to. develop better simulators, partic- Simulators could increase.

As exemplified by the medical residency maxim "see one, do one, teach one," there has been little emphasis on learning in a simulated environment prior to clinical encounters. However, considerable evidence documents the dangers posed by inexperienced clinicians and poorly functioning clinical teams. Based in part on its success in other industries such as aviation, simulation-based training has therefore emerged as a key component of the patient safety movement and is increasingly being used to improve clinical and teamwork skills in a variety of environments. When applied properly, simulation-based training allows the opportunity to learn new skills, engage in deliberate practice, and receive focused and real-time feedback. The goal of simulation-based training is to enable the accelerated development of expertise, both in individual and team skills, by bridging the gap between classroom training and real-world clinical experiences in a relatively risk-free environment. Methods and applications of simulation-based training There are several approaches to simulation training, and depending on the material being emphasized, simulation curricula may employ one or more of these methods: These are used to train specific clinical skills through simulation. An example would be anatomically correct limb models, which are used to demonstrate phlebotomy skills or placement of intravenous catheters. The most common example is a full-body manikin, which in addition to anatomic landmarks can offer realistic physiologic simulation such as heart sounds and respirations. These are increasingly used to teach the physical examination and other fundamental clinical skills. In this modality, learners are immersed in a highly realistic clinical environment, such as an operating room or intensive care unit. Learners physically interact with the environment as they would in real life, using systems that are increasingly complex and technologically sophisticated. This approach refers to simulation carried out in the actual clinical environment with the providers who work in that location. It may involve use of part-task or full-scale simulators as well. Employing trained actors to simulate real patients has long been used to teach basic history taking and physical examination skills, and this strategy is also being applied to teach patient safety skills such as error disclosure. These methods are not mutually exclusive, and successful curricula often use combinations of these approaches. Simulation was initially utilized as a tool for teaching clinical skills and has been successfully applied to develop and assess foundational clinical skills as well as more advanced cognitive and technical skills, in both medical school and residency training. Simulation is also being widely integrated into teamwork training in a variety of environments, including the emergency department , operating room , and obstetrics units. Teamwork training that incorporates simulation often focuses on improving the ability of multidisciplinary teams to handle acute situations. Teamwork training with simulation has also been used with non-clinical personnel, such as one study in which non-clinician leadership and management had to respond to a simulated patient safety crisis. The application of human factors engineering methods to patient safety represents another application of simulation. Usability testing, which refers to testing new equipment and technology under real-world conditions, can be thought of as a form of simulation designed to identify latent safety issues and workarounds. Evidence supporting simulation-based training Simulation training is clearly effective as an educational modality. A recent systematic review analyzed results from more than studies that evaluated technology-enhanced simulation training programs and found strong positive associations between simulation training and improved outcomes of knowledge, skills, and behaviors. Another systematic review identified 38 studiesâ€”most of which used simulation to teach procedural skillsâ€"and found that simulation augments team behaviors, procedural competence, and patient care outcomes. Simulation approaches have been shown to enhance safety outcomes, such as preventing central line infections. While technology-enhanced simulation is effective, increasing technological sophistication of simulation may not always be necessary. According to another review , the key features of successful simulation education are those of successful curricula in general: The effect of high-fidelity technology-enhanced simulation remains controversial , and although the cost of such high-technology simulators is decreasing, their high costs may deter increasing use of this approach until more definitive evidence emerges. The evidence supporting the use of simulation in teamwork training is more mixed. A systematic review that examined simulation training in the operating room found that most studies suffered from one of several methodological concerns, such as lack of standardization of training techniques and measurement methods. While participants generally had positive impressions of the programs, there was no clear effect on participant behaviors or clinical outcomes. Variation in simulation approaches and curricula likely account for these disparate findings. There is increasing interest in using in situ simulation as a way of providing more realistic simulation experiences and potentially identifying latent safety hazards in the real-world clinical environment. Current Context All graduating medical students are required to complete a simulated patient encounter in order to pass the United States Medical Licensing Examination. The Accreditation Council for Graduate Medical Education requires that residency programs provide simulation training, although the specific requirements vary between specialties. The American Board of Anesthesiology requires practicing anesthesiologists to complete a simulation course in order to maintain board certification, but this requirement is not present for other specialties. It is important to note that simulation has been shown to be effective as an educational tool for both practicing clinicians as well as trainees. Related Patient Safety Primers.

Chapter 5 : Simulation Training | AHRQ Patient Safety Network

Many studies have shown that skills learned in flight simulators can be performed successfully in aircraft; the use of simulators for training can reduce flight time. In a more recent study, the median cost ratio of simulators to aircraft was estimated to be 8%.

This article has been cited by other articles in PMC. Abstract Medical education is rapidly evolving. With the paradigm shift to small-group didactic sessions and focus on clinically oriented case-based scenarios, simulation training has provided educators a novel way to deliver medical education in the 21st century. The field continues to expand in scope and practice and is being incorporated into medical school clerkship education, and specifically in emergency medicine EM. The use of medical simulation in graduate medical education is well documented. Our aim in this article is to perform a retrospective review of the current literature, studying simulation use in EM medical student clerkships. Studies have demonstrated the effectiveness of simulation in teaching basic science, clinical knowledge, procedural skills, teamwork, and communication skills. As simulation becomes increasingly prevalent in medical school curricula, more studies are needed to assess whether simulation training improves patient-related outcomes. Although simulation is widely used in medical education, notable variation is found in the modalities used at different institutions and within different specialties. Furthermore, limited research has been conducted to explore the prevalence and types of simulation being used in EM clerkships. We performed a systematic literature search for relevant articles to provide a concise review of the literature. Types of Simulation Currently the types of simulators available for medical education are vast and varied, but most can be categorized as standardized patients, partial-task trainers, mannequins high-fidelity patient simulators , screen-based computer simulators, and virtual-reality simulators. Standardized patients are actors trained to simulate various symptoms, give medical histories, and display various emotions during a medical examination. Although standard criteria for distinguishing between high- and low-fidelity simulators have not been firmly established, these trainers are classified as low to high fidelity, according to how closely they imitate the circumstances under which the skill is typically performed. Virtual reality has become a ubiquitous and relied-on method of training for surgical fields, such as general surgery, ear, nose, and throat, and orthopaedics. This tool shows 3-dimensional images of organs and anatomy to help in training and preplanning the surgeries. Anesthesiology has been a forerunner in adopting simulation in the form of mannequins and screen-based simulators, by using them extensively for resident and faculty practice in endotracheal intubation, mask ventilation, and cricothyrotomy. Confirmatory studies within EM that repeat the studies performed in these other fields would provide more evidence that may support the expanded use of simulation beyond its current uses in EM. Simulation in Emergency Medicine EM, though a relatively young field, has been quick to join its colleagues in adopting simulation technology; however, most available studies have investigated simulation use in training residents, not medical students. A 5-year study by Okuda et al 17 â€" on the growth of simulation training in EM residency programs showed an increase in the use of simulators for training residents. Thus, simulation in EM has proved useful in both the academic and professional spheres of residency education. A review by McFetrich 18 also supports this type of simulation training in EM, documenting that programs using these methods showed significant improvement in emergency airway management and surgical airway management of pneumothorax, as well as significant improvement in ethics application and team performance. In a study conducted by Langhan et al, 19 residents were educated about critical resuscitation procedures by using simulators. The evaluation process consisted of 2 stages, 1 immediately after 8 hours of simulation, and the other, after 3 months. The residents showed improvement immediately and continued to demonstrate benefit after the 3-month washout period. Another study conducted with EM residents in demonstrated the efficacy of high-fidelity simulators in both summative and formative resident evaluation. Simulation-based training has been used to teach advanced cardiac life support to medical students, residents, and paramedics. This type of simulation was shown to improve team coordination, leadership, and patient safety and also to decrease liability. Although these and multiple additional studies support the assertion that simulation is a valuable tool in the training and assessment of EM residents, the body of literature supporting simulation use in EM undergraduate medical education is far from robust. In , the SAEM Simulation Task Force published a research agenda 26 suggesting a wide variety of possible areas of research, including further exploration of the use of simulation in undergraduate medical education. Simulation in Emergency Medicine Undergraduate Education: Literature Review Whether in response to this published research agenda or simply by the natural thrust of a shared curiosity among academic EM physicians, more studies have been published in recent years on the use of simulation in EM clerkships. After removing duplicate results but before reviewing the articles to confirm their relevance, the cumulative results showed 2 articles published from through , 1 article from to , 4 articles from to , 8 articles from to , and 31 articles from to Many of these studies, on further inspection, had included medical students among the subjects used to evaluate a simulation modality or were studies using nursing or pharmacy students, and thus did not provide useful information for the purposes of this review. A number of recent studies into the use of simulation in EM clerkships surveyed students on their perceptions of the educational quality of a simulator after instruction in using the simulator. Afterward, the students were given the opportunity to assess qualitatively the value of the exercise. In , a prospective cohort study conducted at Loma Linda University 28 incorporated simulation into a training session of medical students to manage resuscitation during severe shock and sepsis. The students appreciated the teaching method and also reported that it gave a boost to their confidence level to handle similar cases in the future. Another study conducted in evaluating the efficacy of simulation training for undergraduate medical education 29 received a good response from the participating medical students. In this exercise, 41 students underwent interactive simulator training in a simulator laboratory to learn the basic management of a thoracic injury in the ED. Other studies have evaluated the educational efficacy of simulation by comparing student performance after simulation use with student performance after training by using more-traditional instructional methods. A comparative study conducted at University of California, Los Angeles, 30 compared problem-based learning PBL with simulation for efficacy in teaching fourth-year medical students the management and assessment of critical patients. This randomized control study with 31 subjects showed a greater transfer of knowledge in the simulator-educated students compared with the PBL students. A study conducted by Ten Eyck et al 31 showed how including simulation in the EM curriculum improved medical student performance and satisfaction. The randomized control study consisted of 91 fourth-year medical students divided into 2 groups. The first group was exposed to simulation cases for 2 weeks and then crossed over to join the second group in discussions of sample cases. At the end of 4 weeks, both groups were tested for number of questions answered correctly and assessed for student satisfaction. Students from the simulation arm scored significantly higher than students in the case discussionâ€”based training. Although students found the simulation exercise stressful, they preferred it to case discussions, stating that they found the approach safe and appropriate for their level. Published in the Canadian Journal of Emergency Medicine, Franc-Law et al 32 compared traditional didactic lecture plus disaster medical simulation to didactic lecture plus nondisaster simulation. Twenty-two students were divided into 2 groups, and then evaluated after the training. Performance of the students in the intervention group was significantly better than the control nondisaster scenario group. Subsequently, the students rated the simulation training highly 8 of 10 on a Likert scale on satisfaction in preparing them for disaster management. A randomized crossover study in by McCoy et al 33 evaluated the performance of 28 fourth-year medical students in the management of myocardial infarction MI and anaphylaxis after training with a human patient simulator SIM or a PowerPoint lecture LEC. Half of the students were taught about MIs via LEC, whereas the other half learned on SIM, and then the students switched learning modules for instruction on anaphylaxis. Twenty-seven of the 28 subjects demonstrated better assessment and management skills after the SIM instruction in comparison to the LEC instruction. Not all of the available research supports the assertion that simulation instruction is more effective for undergraduate medical education. At the end of the month, all of the students took the same examination evaluating their knowledge. The groups were analyzed and determined to have no significant differences in gender, age, or specialty preference. A multivariate analysis of variance showed no significant difference in student performance on the examination between the HPS or EBL groups. A randomized control study by Gordon et al 35 used pretest and posttest evaluation of undergraduate medical students to compare the educational efficacy of simulation with didactic lecture. Although the students improved their performance from pretest to posttest, no significant differences in performance were found between the students learning via didactic instruction and those taught with the simulation modality. A study conducted by Graber et al 36 investigating how simulator training of undergraduate medical students might affect patient perceptions suggested that simulation may improve patient perceptions of students performing procedures during their EM clerkships. The studies conducted thus far involving the use of simulation for education of undergraduate medical students in EM clerkships either assess approval by students, compare the educational efficacy of simulation versus didactic lecture, or, as shown by Graber et al, 36 explore benefits such as patient satisfaction. Although the superior efficacy of simulation for instruction of medical students over other modalities such as didactic lecture or problem-based learning has been supported in several low-powered studies, other similar studies, although demonstrating the equivalent utility of simulation, have not shown simulation to have superior efficacy. Perhaps simulation provides better instruction for certain tasks, such as professionalism and technical skills, whereas didactic or problem-based learning teaches patient assessment and treatment algorithms more effectively. Stratifying the simulation efficacy studies based on the task the simulator is intended to teach or assess could elucidate the value of simulation for the instruction of specific tasks. This would provide invaluable information to future simulation designs and to the development of highly effective curricula for undergraduate medical education. Decisions on the application of simulator modalities for education in EM clerkships will continue to be based on sparse evidence, anecdotal support, and speculation until more studies are conducted to expand the body of literature, increasing the strength of evidence, and allowing a stratification of the studies. Academic inquiry into the efficacy and popularity of simulation in EM clerkships has clearly increased greatly over the past decade, as demonstrated in the literature search. However, a need remains for documentation of the current state of simulation use in EM clerkships nationwide. Determining the prevalence of simulation use in EM clerkships, the types of simulators used, and the specific purposes the simulators fulfill in training or evaluating the students may provide a starting place for investigators to design studies that will prove the most relevant to EM clerkship directors and other educators. As we embrace simulation-based medical education as a valuable tool for training and assessing medical students and residents, we need research into the impact of simulation on patient care, safety, and satisfaction, with only a few positive studies showing improvement in patient-care outcomes. Future studies are needed to determine the efficacy of simulation training in medical student education in comparison to more traditional modalities and the influence of this training on patient care. Although different institutions will have different resources to bring to bear for undergraduate medical student education, based on this review, the allocation of some resources and the inclusion of some level of medical simulation seems prudent. Footnotes Supervising Section Editor: Christopher Kang, MD Reprints available through open access at http: By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources, and financial or management relationships that could be perceived as potential sources of bias. The authors disclosed none. Simulation in graduate medical education National growth in simulation training within emergency medicine residency programs, â€” Lloyd L, Greenberg G. Practical Health Care Simulations. The utility of simulation in medical education: Mt Sinai J Med. Simulation in undergraduate medical education: Using high-fidelity patient simulation and an advanced distance education network to teach pharmacology to second-year medical students. Using cardiovascular and pulmonary simulation to teach undergraduate medical students: Semin Cardiothorac Vasc Anesth. Teaching pulmonary gas exchange physiology using computer modeling. Isr Med Assoc J. Simulation technology in anesthesiology. J Perinat Neonatal Nurs. Recurrent obstetric management mistakes identified by simulation. Attempted establishment of proficiency levels for laparoscopic performance on a national scale using simulation: Virtual reality training improves operating room performance: A structured literature review on the use of high fidelity patient simulators for teaching in emergency medicine. A theme-based hybrid simulation model to train and evaluate emergency medicine residents. CPR in medical schools:

Chapter 6 : Learning with Simulation Reduces Safety Risks

UNCLASSIFIED UNCLASSIFIED Use of Simulation to Improve the Effectiveness of Army Welding Training Executive Summary Welding is an important manufacturing technique used in a variety of industries, such.

Limited to available targets and terrains Visual Replay of Mission Performance measures: Using Aircraft Simulators to Train Fleet Aviators May Training in a simulator has advantages [over training in the actual aircraft], such as more cockpit time for the money, greater flexibility in designing the scenario, and more effective interaction with the instructor. More specifically, simulation provides the following: The simulator is not constrained by the logistics and cost of scheduling opposition aircraft, range time, warning areas, etc. A simulator scenario is not constrained by safety, environmental, diplomatic, security, and other real-world peacetime limitations. A simulator scenario does not have to contend with unrealistic physical requirements. For example, when simulated aircraft are killed, they can be immediately removed from the scenario. The design of a simulator scenario can be more flexible, which means it can more easily be tailored to situations that are particularly important or to situations that the student is having difficulty with. The simulator can provide the student with more trials in a given block of time by eliminating tasks that are not central to the training objective e. Simulator scenarios are reproducible, so they can be used to teach lessons that require repetition. The instructor can provide the student with cause-and-effect feedback almost immediately, when it is most effective. In the Phase 1 navigation test, the VE Training group was an average of 30 seconds faster over a two minute run. In addition, all of the Traditional Training group made at least one wrong turn, while only one VE Training group member made any wrong turns. In Phase 2 the firefighting test , the majority of the participants in the Traditional training group made wrong turns but no one in the VE Training group did. Timing data was recorded in Phase 2 but individual differences in team leadership style and differences in the actions of the firefighting team made timing measurements inconclusive. In addition to the quantifiable results obtained during the tests, participants expressed their increased confidence in performing their tasks because of the familiarization of the spaces and situation awareness that they received through VE. Most members of the VE Training group used VE to actively investigate the scene and plan their strategies, so that during the fire they were able to concentrate on fighting the fire instead of finding their way through unfamiliar spaces. The on-line report is a reprint of: Based on the successful results of the VE Feasibility Tests conducted on the ex-USS Shadwell, the recommendation was to support the development of techniques for enhancing VE as a training system. Motorola University Virtual Trainer http: Three training groups of seven students each were trained to perform various tasks. Each group was taught by the same Master Instructor. Everyone had the same classroom instruction. The two VR groups each had 20 minutes of navigation instruction and familiarization, so they could move easily in the virtual lab. The control group spent one hour in the real lab. With the help of job aid checklists, they worked through the procedures on the real equipment. The instructor was nearby to answer questions. The Desktop VR group used the virtual lab, which they saw on monitors, and used a 2D mouse for navigation. They also navigated using 2D mice. The VR groups also had one hour for learning in the virtual lab, with an instructor and checklists. Following the familiarization time, each person individually went into the real lab, and without the checklists performed the procedures under the eye of the instructor. Each student was graded on the number of errors and missed steps. Results of the testing showed that the VR Groups spent more time on any given training task. There were three perfect scores: The total number of errors possible is in the hundreds. Integrated Damage Control Training Technology http: However, the cost, time and resource availability associated with Damage Control DC exercises have posed limitations to this much needed training. With the belief that DC training could be implemented more cost-effectively, a multi-disciplined group consisting of education professionals, experienced multimedia developers, subject matter experts, and other technical personnel convened to address this issue. This prototype provided trainees a mechanism to test their knowledge and ability in situations made stressful through interactive video technology without the associated cost of bringing an entire ship to general quarters. Subsequent field testing at these training commands received great acceptance. Feedback from both students and instructors at the installed sites showed and enthusiasm for the concept of the trainer; however, IDCTT was developed as a prototype and was limited in its capabilities. A full-lifecycle, multimedia trainer system was therefore recommended to compensate for the shortcomings in the IDCTT prototype. Although initially targeted at shore-based training sites, this trainer has potential as an embedded training module in an operational shipboard system, much like the Damage Control System DCS. The RPL shall be packaged as a COTS product designed to run on any MPC II compliant system running a 32 bit operating system , allowing dual use of hardware in stand-alone mode, but shall also include a network interface to the DCS system to integrate with the operational system as embedded trainer. Red Flag Remote Briefing Tool http: This is the first ARPA project to successfully integrate real-world and virtual environment actors into one large-scale distributed virtual environment. RDT strips out aircraft position, motion, telemetry, and weapon control status data from the Red Flag Monitoring and Debriefing System in real-time and uses the DIS protocol to send this information to any location with a DSI connection. This information could also be sent over any other network as long as the DIS protocols are used. The receiving site can present the transmitted data as either a 2D or 3D view of the range. RDT provides much of the functionality of the debriefing system located at Nellis, but on a 21" monitor. As a result, the system is inexpensive and portable. Virtual Emergency Room http: This system may serve to reduce hospital costs and the length of stay for trauma patients admitted through the ED. In addition, the system is suitable for use in mobile military field hospitals. The vehicle for this step is the recent advances made within virtual environment technologies. Virtual environment technology can be defined as the human experience of perceiving and interacting through displays, sensors, and effectors with a virtual environment and its contents as if it were real. To implement a virtual environment requires the use of several different technologies. Users of the environment must be given visual and audio cues that are sufficiently accurate to entice the user to suspend disbelief in the virtual environment presentation. In addition, sensors to determine the users position and orientation and a mapping for them from the real to virtual world are needed. Finally, devices that allow the user to control appropriate portions of the environment and the display of the environment are needed. To meet these requirements researchers have investigated rendering techniques and requirements, image display devices,input devices, output devices, sensors, environment descriptions, user interface paradigms, and the virtual environments that could be built with these advances in equipment. The principal objective of our project is to develop a state-of-the-art virtual reality environment for use within level I and II Emergency Rooms. The system is now under construction. Employing extensive databases on targets, ocean environments, and sonobuoy patters, this system enables fleet personnel to create multiple scenarios during training sessions. We provided a full gamut of engineering services for this effort including design, code, test, debug, and integration of all computer program modules. Intermetrics has also developed and integrated several ASW support laboratories. Another lab, the ASW Engineering Laboratory will be a platform independent facility used to assess available and advancing technologies. As a generic evaluation lab, it is expected to increase the overall effectiveness of fleet operations. For more information, please contact Bruce Waldron at or waldron warm. Dave Stevenson and John Bettner engineers with Caterpillar in collaboration with the staff of NCSA National Center for Supercomputing Applications have put together a system which allows them to quickly prototype wheel loader and backhoe loader designs. In particular the team is able to perform visibility assessment of the new design. Engineers put on a helmet mounted display and have a full degrees of vision to see how the environment looks and to evaluate obstructions. A Silicon Graphics is used to generate the real time graphics display and to simulate the operation of the equipment. The engineers can "operate" the equipment and evaluate visual obstructions in a natural manner without having to build a physical prototype. Select it to view a short MPEG movie of the facility in action. In the press release announcing the award: This showed up in briefing material provided to senior DoD people at the end of June Lockheed may be able to provide some specific targets that they are trying to achieve utilizing SBD. To date there have been seven separate requests satisfied with copies of this very useful software. The development of this software is estimated to save a user approximately 6 man months of effort. In addition to the completed software identified above, we at STRICOM have received two separate requests for copies of our developmental software used in our Dynamic Terrain project even though the software is in a transitional state. Both of these projects together are estimated to represent a developmental effort of approximately two man years. Gulf War Analyses http: However, it has also contributed significantly to combat operations. It is a hybrid model with Monte Carlo and deterministic features. Since the modeled air defenses, unlike the actual air defenses, acted in a rational manner, the simulation results showed a worst case scenario for the actual air assault. One main contribution was to choreograph the masses of aircraft into and out of the Kuwaiti Theater of Operations to avoid mid-air collisions and to schedule the rendezvousing of tankers with attack aircraft. They also analyzed the best use of defense suppression assets, and alerted planners of missions that were too hazardous for some aircraft. For instance, their analyses indicated that it would be too dangerous to carry out plans to send A-6 and Tornado aircraft directly over Baghdad. As a result only F stealth fighters, none of which were lost, were assigned targets in that highly defended area. These changes undoubtedly saved lives and the needless loss of aircraft. When they determined that SCUD sites in Western Iraq were too well defended and as existing prior to the attack too hazardous for FE attacks, defense suppression missions were reconfigured to correct the problem. When aircraft losses occurred, computer simulations were used to help determine the most likely cause so that later missions could be made less dangerous. To ensure that aerial tankers would make their rendezvous with fighters in need of refueling, missions were played out in advance. The WSSFs use a combination of actual aircraft hardware and software, together with extensive modeling and simulation to provide a cost effective test platform. In addition to saving money, WSSFs enable testing to be conducted that would otherwise be impossible. Each subsystems is modeled, and all subsystems are combined to form a system level simulation. This simulation is used to prototype initial developments--allowing pilots and engineers to refine their requirements prior to actual hardware and software development. During development, each upgrade is tested in the WSSF to determine if it meets requirements and to ensure that the modification does not adversely affect other aspects of system performance.

Chapter 7 : Gleim Virtual Cockpit: Flight Simulator Platform Built by Pilots

Endoscopic simulators have been developed for training in esophagogastroduodenoscopy, colonoscopy, and endoscopic retrograde cholangiopancreatoscopy (ERCP). Evidence in the literature supports the use of endoscopic simulators as valuable tools in learning these endoscopic procedures.

In these pointâ€"counterpoint articles, Drs. Pratt and Sachs of Beth Israel Deaconess Medical Center argue the advantages of classroom-based teamwork training without high-fidelity simulation. In the companion article, Dr. Gaba of Stanford focuses on the unique merits of high-fidelity simulation in improving communication, teamwork, and procedural safety. Pratt, MD and Benjamin P. Sachs, MB In recent years, the medical community has reached a near-consensus that team training and Crew Resource Management CRM techniques can improve patient safety. However, the most effective way to teach and implement these concepts is much less clear. Options include high-fidelity simulation and classroom-based systems. For instance, students may enact a scenario that teaches them to use appropriate, closed-loop communication this is when the sender initiates communication, the receiver confirms that the communication has been heard and repeats the content, and the sender verifies the accuracy of that content. Alternatively, they may practice conflict resolution or other strategies to improve the culture of safety. However, classroom-based team training does not require an expensive, high-fidelity simulated environment. In contrast, this technique consists of lectures, instructional vignettes or videos, cases reviews, interactive problem-solving exercises, question-and-answer sessions, and examinations to test knowledge. There are two sets of goals when bringing CRM concepts to medicine. The first, and easiest to achieve, is to teach the necessary knowledge, skills, and attitudes KSAs. The techniques to accomplish this are well known. Knowledge can be taught by didactic lectures, case-based teaching, on-line or print texts, interactive scenarios, or other similar techniques. It can be assessed by pre- and post-tests. Both class-based and simulator systems can effectively teach the basic KSAs. Class-based training has been shown to positively influence team attitudes 2 and skills. First, it does not need an expensive, specialized environment. The purchase price of a high-fidelity obstetrics simulator can easily reach into tens or even hundreds of thousands of dollars for the most realistic models. In addition, staff must be employed to operate and maintain the simulator. The purchase and operating costs lead directly to high team-training implementation costs. This does not include training residents, unit coordinators, scrub technicians, or others who are part of the team, but who are frequently not included in the simulator-based scenarios. Alternatively, training our entire staff in CRM techniques using a 4-hour classroom course required small costs for copying educational materials, the manpower costs to get trainers out of their clinical environments a total of about person-hours , the costs of meals we provided at the 4-hour sessions, and other small miscellaneous expenses. Gaba argues that high-fidelity simulation is superior to other educational methods, contending that the "realistic" environment of the simulator improves the learning environment and increases the opportunity to practice the KSAs. However, this has never been demonstrated. Several authors have suggested that low-level simulation, as could be used in a classroom, is likely to be as effective in teaching teamwork techniques as the costly high-fidelity variety. The second advantage of classroom-based education is that it allows more staff to be trained at once. Up to 40 people per session have been effectively trained in one model 2 , which comports with our experience as well. Finally, class-based teaching is easy to schedule as part of the staff orientation process, as it does not require staff to leave their environment in order to get to the simulator. Thus, new staff can quickly and efficiently be taught the KSAs they must know in order to work on a unit steeped in CRM concepts. The second goal of team training is to successfully transfer the KSAs to the clinical arena and to improve patient safety. This is the more important and the more difficult task. It is unlikely that any single intervention, either classroom or simulator-based, is likely to effect a permanent change in the culture of medical care. The post-teaching implementation phase consists of several steps. First, the teamwork concepts are rolled out in stages. This allows staff to integrate them into their practice as a group and to practice them one at a time. The roll-out plan should be carefully scheduled in order to keep staff from being overwhelmed by the multiple changes. For instance, simply having team meetings each shift may be the goal for several weeks. This can be followed by other team behaviors closed loop communication, task assistance, cross-monitoring, etc. Coaching is the second step in the implementation process. Teamwork champions are placed on the unit to coach the behaviors as they are rolled out. This reinforces the KSAs learned during the teaching phase and helps to translate them into clinical practice. The coaching effort may add cost, as the coaches might have to be compensated for their time spent on the unit, but these funds can be taken from monies saved on the teaching phase. Finally, encouragement and feedback, especially from leadership, are essential to the implementation process. This can come in the form of sharing teamwork success stories or in sharing data collected from coaches on the success of the implementation process. Based on our experience, this implementation process takes months. It requires constant reinforcement of the KSAs learned in the classroom and ongoing coaching and mentoring by clinical champions committed to the process. They teach and coach CRM concepts such as cross-monitoring, conflict resolution, effective communication, and others in real time and in the environment in which they are needed. The difficulties in implementation of team training highlight one of the differences between medicine and aviation see related Perspective and interview ; namely, the "flight" is not always well defined in medicine. Procedure-based units such as the operating room or the GI suite are easily compared to aviation. They have planned procedures, with a scheduled time, expected course, and projected end point. They have a well-defined "cockpit" crew. These units can make use of many CRM concepts such as "pre-flight" briefings, checklists, and structured moments "time outs" for error reduction. In these types of units, practicing the pre-procedure processes in a simulated environment might be helpful in reducing error although one must still question whether costly, high-fidelity simulation is necessary. However, in most medical environments eg, the emergency department, labor and delivery, medical wards, ICUs , no such schedule exists. These environments require that teamwork concepts be applied to the management of the entire unit, not simply to the patient or procedure, in an effort to reduce, mitigate, and effectively respond to adverse events. Staff must learn to develop situation awareness for and cross-monitoring of multiple caregivers, caring for multiple patients with multiple medical issues in a dynamic, unscheduled environment. One cannot have a pre-determined checklist in the emergency department because it is not possible to know what the emergency will be, when it will arrive, or what resources it will require. Rather, team training in these environments must create a structure and a culture that encourage the tenets of teamwork. Teamwork has to be more fluid and able to adapt to the many "take-offs" and "landings" and mid-air crises that occur without a defined start or end. We believe that high-fidelity simulation is highly limited in its ability to effectively teach this CRM-based unit management, partly because it has overemphasized crisis management ie, the management of major adverse events instead of the management of the resources, workflow, and teamwork on a unit. Although this could be changed, it would require a significant philosophical shift in the way simulators are run. In addition, it would simply be cost prohibitive to build simulated environments with multiple patients and many caregivers. In contrast, class-based team training has been shown to change behavior and improve patient outcomes in the clinical arena. Morey and colleagues demonstrated improved teamwork behaviors and clinic outcomes in emergency departments where staff underwent MedTeams training. Although proving that these outcomes were directly caused by our classroom-based CRM program is difficult, this was the major intervention over this period, and we believe that causality is highly likely. Ultimately the best way to teach and implement team training may be through a combination of classroom training to teach the KSAs and simulator-based training to practice crisis management. However, given the current costs and as-yet unproven benefits of high-fidelity simulation, we believe that classroom-based training, followed by intensive coaching during implementation, is the most effective method of bringing CRM concepts to most medical environments. Medical team training programs in health care. Advances in Patient Safety: From Research to Implementation. Agency for Healthcare Research and Quality; February Accessed February 21, The impact of aviation-based teamwork training on the attitudes of health-care professionals. J Am Coll Surg. Error reduction and performance improvement in the emergency department through formal teamwork training: Evaluation results of the MedTeams project. It is not how much you have but how you use it: Int J Aviation Psych. The use of simulation for training teamwork skills in health care: Qual Saf Health Care. Myths about crew resource management training. The future vision of simulation in health care.

Chapter 8 : Defense Department to reduce use of live animals for medical training

â€¢ how simulation and simulators are used for U.S. Navy training for the DDG class ship â€¢ the use of simulation in other military organizations, in civilian.

Advancing Medical Education and Patient Safety through Simulation Learning ABSTRACT Medical simulation with computer-controlled simulation technology enables students and providers to learn, practice, and repeat procedures as often as necessary in order to correct mistakes, fine-tune their skills, and optimize clinical outcomes. They can develop and refine their skills without compromising the safety of real patients. Medical simulation at the Center is improving the education of medical and nursing students, residents at Regions Hospital, and practicing providers. Simulation is an important solution to the challenges of patient safety. Enhanced and more effective professional education and with reduced safety risks for actual patients. Integrating simulation into traditional medical education programs and securing stable sources of ongoing financial support to keep pace with advances in medical simulation technology. While hands-on, experiential learning is indispensable, medical educators are increasingly concerned about, and committed to, the safety of patients. The reality, however, is that making mistakes is an expected and inevitable part of the learning process, and mistakes are a real risk to patient safety. And at the same time, learners gain confidence in their ability to perform clinical skills with actual patients. In medical simulation, computer-controlled equipment advances medical learning and ensures that students learn procedures and treatment protocols before using them on actual patients. A simulation environment allows students and providers to learn, practice, and repeat procedures as often as necessary in order to correct mistakes, fine-tune their skills, and optimize clinical outcomes. In addition, with simulation, students and residents can gain experience with various types of patients and cases they may not actually encounter during their rotations and shifts. This is particularly significant for training in managing emergency situations. Patients with serious and volatile conditions may not get second chances. Research studies indicate that simulation improves learning Grantcharov, et al. Simulation is especially effective in developing skills in procedures that require eye-hand coordination and ambidextrous maneuvers, such as bronchoscopy. Simulation training helps learners prepare to deal with unanticipated medical events, develops teamwork and communication skills, increases confidence, and improves performance. Interest in the benefits of medical simulation is increasing, as evidenced by the establishment in January of a new multi-disciplinary, multi-specialty, international society, the Society for Medical Simulation SMS , www. SMS represents the fast-growing group of medical educators and researchers who utilize a range of simulation techniques and technologies for education, testing, and research. The membership is united in its commitment to improve performance and reduce errors in patient care using all types of simulation including task trainers, human patient simulators, virtual reality, and standardized patients volunteers who act out clinical situations. Establishing a Simulation Center in Minnesota Brian Goodroad, assistant professor at Metropolitan State University School of Nursing, uses simulation to teach graduate nursing students pathophysiology and advanced patient assessment skills. Photograph by Renee Whisnant, courtesy of Minnesota Medicine. HealthPartners is a family of nonprofit, consumer-governed healthcare organizations that include a ,member health plan covering nearly one in four residents of the Minneapolis-St. Paul metropolitan area , the bed Regions Hospital, and the HealthPartners Medical Group, with physicians at 28 primary care and specialty care clinics. In conjunction with the University of Minnesota Medical School, HealthPartners trains more than resident physicians in 16 medical specialties each year at Regions Hospital. IME also provides continuing medical education for HealthPartners physicians, nurses, and other medical professionals as well as providers from around the Midwest. Paul campus is a three-minute drive from Regions Hospital, where HealthPartners and the University of Minnesota train medical students and residents. Together, HealthPartners and Metropolitan State designed and built a functioning medical simulation center in 12 months. Medical Simulation Technology The equipment and simulation training procedures at the Simulation Center are designed to make learning realistic for students, residents, and providers. Five kinds of training are available at the Center: Attached monitors display vital signs. It provides virtual simulation of almost every major bodily function. This simulator can be used for a range of scenarios from physical examination to major trauma. For instance, the virtual patient can be programmed to have a heart attack, with other sudden complications. The simulator even recognizes injected medications via a laser bar-code reader and responds with appropriate vital signs. It is particularly helpful for practicing the teamwork and communication required during heart attacks and other major clinical events. HealthPartners and Metropolitan State have added a pediatric human simulator and plan to introduce an obstetrics simulator in Four examination rooms are available for practicing patient exams and communication skills. In addition, there are procedure skill rooms for venous catheterization and other procedures. A simulated operating room will open in It will support simulation training on sterile technique, surgical team roles and communication, and patient safety in the operating room. Using these simulation programs, students insert the fiber-optic scope into a special computer console, designed to be anatomically realistic, instead of a real patient. Learners move the dials on the handpiece exactly as they would with a real scope, following their movements in real time on a detailed computer screen image of the lungs or colon. Another simulator allows students to practice blood-drawing techniques, from skin cleaning and needle selection to puncture technique and aftercare. A nursing team from Regions Hospital in St. Paul practices emergency response on the human patient simulator. Significantly, the simulators present a variety of different clinical scenarios that simulate many types of patients with different diagnoses and pathology. Therefore, students practice much more than procedure technique; they learn to apply their skills in a range of realistic clinical situations. A fully functional EMR is provided in the four clinical exam rooms, complete with fictional patient histories, notes, and lab results. Observers in the conference room can watch a learning activity and offer feedback. Learners also have the opportunity to watch recordings of their learning activities to observe their performance and identify opportunities for improvement. Simulation Learning for Emergency Medicine Residents The traditional process of clinical education in emergency medicine, like other specialties, relies on learning and practicing diagnostic, therapeutic, and procedural skills on real patients. Computer-controlled simulation is now opening up new educational applications that show considerable promise in emergency medicine Small et al. This is evident at the HealthPartners Simulation Center. The emergency medicine EM residency program at Regions Hospital was established in , and the first class of residents began their training in The Regions EM residency has graduated 38 residents from 17 different medical schools, and they now practice in 14 states. Nine physicians begin their three-year EM residency annually at Regions. According to Felix K. Ankel, MD, assistant professor of emergency medicine and residency director, excellence in patient care requires a combination of knowledge, skills, and attitudes. Medical educators tend to focus on knowledge, because it is the most straightforward component to teach and test. Thus, acquisition of skills and cultivating essential attitudes traditionally come in on-the-job training. Experiential learning is essential, and simulation enhances this aspect of the EM residency program Ankel, Residents spend 30 to 40 hours per year at the Simulation Center. That equates to five emergency room shifts annually. Hegarty, MD, is the assistant EM residency director at Regions and also serves as the director of medical student education and director of medical simulation. He uses the technology of the Simulation Center to teach basic procedural and patient management skills Hegarty, The adult and pediatric human simulators are used to conduct a variety of different trauma and resuscitation scenarios, which include procedures such as establishing emergency airways. Residents also practice setting up central lines in the venous catheterization procedure room and utilize the bronchoscopy simulator. Exposing residents to common emergency medicine cases, such as strokes, early in their training enables them to ascend the learning curve faster. In addition, Hegarty believes that simulation plays a critical role in supplementing experiential learning that residents derive during their emergency room shifts. Residents can be introduced to low-frequency, high-risk adult cases, such as rare toxicities, that they might not see and experience in the real emergency room. And most critical care patients are adults. Thus, the pediatric simulator offers indispensable experience in managing cardiac arrests in children and pediatric trauma. Hegarty and his colleagues are designing new applications of simulation. These include teaching advanced pediatric airway procedural skills with the bronchoscopy simulator and immersing residents in a range of toxicology cases and scenarios using both human simulators. Emergency medicine residents have to learn to make quick decisions with limited data while responding to unexpected events. At Regions, a substantial portion of that experience is gained, without risk to patients, in simulation training. They must also learn critical care team management. Hegarty and Ankel immerse junior and senior residents in increasing complex clinical scenarios so that they have the opportunity to learn teamwork and develop their ER team leadership skills in realistically complex, challenging, and stressful emergency situations. Whereas it is difficult, and often impractical, to review cases in the emergency room during their busy shifts, at the Center residents go to a classroom to replay tapes of simulated scenarios. Faculty and the residents review, discuss, and critique the case management process. Simulation training is thereby used not just to teach and practice procedural skills but to teach the residents to function in teams and to lead them. A major focus of the Pursuing Perfection quality improvement initiative at HealthPartners is to put evidence-based best practices into practice. As guidelines and care pathways become increasingly important in the practice of emergency medicine, simulation is proving to be useful and effective in teaching and practicing protocols. Residents see and learn the workflow steps of various protocols including managing chest pain, strokes, pneumonia, and sepsis , experience the logic of protocols, and internalize the policies. Simulation training reinforces fastidious attention to deal. How do the emergency medicine residents respond to simulation learning? According to Ankel and Hegarty, it is clear that the residents experience the tension and feel the pressure of dealing with seriously ill patients in crisis situations in the simulation scenarios. They appreciate the chance to simulate cases that they may not see in their emergency room shifts, as opposed to just reading about them in textbooks and hearing about them in lectures. Most of all, they value opportunities to make mistakes and learn from them in a safe educational environment. He adapted this standard curriculum for simulation and has become an enthusiastic supporter of simulation. Harris believes the human simulator is a much more effective tool than a mannequin when it comes to learning procedures such as intubation. Simulation is used to teach skills like airway management and to integrate those skills into complex and realistic patient scenarios. Many practicing physicians may recall practicing intubation with a mannequin, an "Airway Annie. Learners feel the pulse and hear the breath sounds. The simulator responds to medications, and teams have to react to unfolding clinical scenarios and unexpected events in real time. Healthcare organizations across the nation are coping with the severe nursing shortage. Some 70 percent of all hospital chief executives reported in October that their facilities were experiencing shortages AACN, When they do hire new nurses, how many healthcare organizations have tested their competency before they start treating patients?

Chapter 9 : Simulation in Medical School Education: Review for Emergency Medicine

The Royal Thai Air Force (RTAF) plans to make increased use of simulators for training pilots, according to group captain Verachon Pensri, the senior instructor pilot at the RTAF's Flying.