Enhancing the Utility and Effectiveness of Combat Medic Simulation

Danielle Julian
MESH
Orlando, FL
djulian@mesh.dsci.com

Teresita Sotomayor
ARL-HRED STTC
Orlando, FL
Teresita.Sotomayor@us.army.mil

John Killilea, Patricia Bockelman,
Margaret Nolan
MESH
Orlando, FL
jkillilea, pmorrow
mnolan@mesh.dsci.com

ABSTRACT

The U.S. Army Research Laboratory (ARL), Human Research and Engineering Directorate (HRED), Simulation and Training Technology Center (STTC) enhances warfighter readiness through research and development of engineering solutions by placing the right technology in the hands of soldiers in the shortest time. To accomplish that goal, the STTC supports training transformation and the promotion of learning to reach diverse Army specialties, such as medical training. Contributing to the efforts of specialized Army medical training, the present work expands on research the team conducted under a 2013 Front-End Analysis (FEA) examining Army nursing training gaps and best practices. Participants reported the largest barrier to using the available simulators is in creating and implementing appropriate scenarios.

To determine whether other military medical training personnel report the same barrier, a follow-on FEA was conducted targeting combat medics (also known as 68W), who serve as specialized warfighters tasked with providing pre-hospital care under the complex and stressful conditions of conflict. Scenario-based training is an integral part of their required course for the 68W designation. Effective scenarios that incorporate best practices in the use of available simulators create the conditions to maximize Return on Investment (ROI).

The data collected from the combat medic FEA will be leveraged to provide recommendations for best practices in scenario design and Simulation-Based Training (SBT). These recommendations are intended as practical, jargon-free considerations that training developers and decision makers can apply to combat medic training. The best practices include, but are not limited to, the following areas: integrating simulation into training curriculum, methods for debriefing and achieving skill acquisition, methods for achieving critical thinking, confidence and perceived competency, and evaluation/assessment. The paper will close by mapping out the relationship between successful scenario development and return on investment for simulation technologies to support the larger STTC mission.

ABOUT THE AUTHORS

Danielle Julian is a Human Systems Research Scientist at MESH Solutions, LLC, a DSCI ® Company. Her background includes research in Human Factors and learning and training. She holds a Bachelor's degree in Psychology and is currently pursuing a Master of Science in Modeling and Simulation at UCF.

Teresita Sotomayor is a chief engineer and subject matter expert in the area of severe trauma simulation at the U.S. Army Research Laboratory (ARL), Human Research and Engineering Directorate (HRED), Simulation and Training Technology Center (STTC). Her expertise in user-centric design and technology effectiveness evaluations has been instrumental in the development and transition of modeling and simulation solutions in support of medical training. She is a graduate of the University of Puerto Rico (Mayaguez Campus) with a degree in Industrial Engineering. She holds a Master of Science degree in Operations Research Stochastic Simulation from The George Washington University and a Doctorate in Modeling and Simulation from the University of Central Florida. She is a member of the Army Acquisition Corps since 2003 and has over 26 years of experience in the modeling, simulation, and training domain.

John P. Killilea holds a Master of Science degree in Modeling & Simulation and is currently pursuing a Ph.D. in the Human Systems track of the Modeling & Simulation program at the University of Central Florida (UCF). He recently worked three years as a Consortium Research Fellow at the U.S. Army Research Institute (ARI) for the Behavioral and Social Sciences, Technology-Based Training Unit. Currently, in addition to being a Doctoral student, he works full-time as a Human-Systems Scientist at MESH Solutions in Orlando, FL.

Patricia Bockelman is a Human Systems Research Scientist at MESH Solutions, LLC, a DSCI® Company. Her background includes research in cognitive science, intelligent behavior, learning and training, and simulation environments. Her expertise includes applying interdisciplinary techniques to combine neurophysiological, psychological, and phenomenological metrics to evaluate human experience. She holds a Master of Science degree in Modeling and Simulation with a Human Systems focus, a Master certificate in Cognitive Science and a Doctorate in Modeling and Simulation from the University of Central Florida.

Margaret Nolan is a Program Manager at MESH Solutions, LLC, a DSCI ® Company. She has over 25 years of experience in providing Human Factors, Cognitive Psychology, and Human Systems Integration (HSI) expertise, and project management support for numerous USMC, Navy, and Army training and simulation systems from development to final delivery as well for as Research, Development, Test and Evaluation efforts (RDT&E). She is certified in and has applied experience with implementing the human systems integration processes, ROI, and sustainment efforts.

Enhancing the Utility and Effectiveness of Combat Medic Simulation

Danielle Julian
MESH
Orlando, FL
djulian@mesh.dsci.com

Teresita Sotomayor
ARL-HRED STTC
Orlando, FL
Teresita.sotomayor@us.army.mil

John Killilea, Patricia Bockelman, Margaret Nolan
MESH
Orlando, FL
jkillilea, pmorrow, mnolan@mesh.dsci.com

INTRODUCTION

The military medical community faces challenges in advancing training effectiveness and efficiency of readiness. Much of this stems from the fact that realistic, hands-on training is difficult to provide, especially to military medical trainees, simply due to the nature of the specialty. As the "real thing" is problematic to leverage for training, the medical community has predominantly turned to Simulation-Based Training (SBT) technologies. These offer vital training benefits precisely because they offer trainees hands-on practice during the crawl, walk, and run phases of training. SBT has been shown to improve trainees' Knowledge, Skills, and Abilities (KSA) (Gaba, 2004) as well as facilitate the transfer of tactics and techniques to real world applications. However, military medical personnel's relationship to SBT is unique, in that instead of being just a part of their final training, it frequently *is* their final capstone training. For the majority of combat medics, SBT is the highest level of training they receive before they deploy, so it is vital that the simulation-based technologies they use are effective, easy to use, and provide capabilities that are sufficient to meet the training requirements. As such, continual systematic evaluation of current training techniques, technologies, and methods identifies new gaps, addresses existing ones, and optimizes overall utility and effectiveness of medical training. The U.S. Army Research Laboratory's (ARL) Human Research and Engineering Directorate (HRED) Simulation and Training Technology Center (STTC) conducted a Front-End Analysis (FEA) to investigate best practices and potential gaps in medical simulation training systems. The main objective of the analysis was to capture the complex and dynamic nature of training with human-in-the-loop technologies.

Although the primary focus remains on U.S. Army combat medics (also known as 68W), this paper first expands on research conducted for a FEA examining U.S. Army nursing training gaps and best practices (Marraffino, Schatz, Tanaka, & Nolan, 2013). This work found several shortcomings regarding implementation and utilization of SBT, as reported by the interviewees, that limited the effectiveness and usability afforded from each simulation type. To determine if other military medical training personnel report similar training barriers, a follow-on FEA was conducted targeting combat medics, who serve as specialized warfighters tasked to provide pre-hospital care at point of injury under the complex and stressful conditions of conflict. The findings, resulting from multiple site visits and exchanges with 68W Subject Matter Experts (SMEs), established a baseline for current training methods and technologies and revealed unique barriers to medic SBT versus Army nursing SBT. This analysis includes the distinct barriers that distinguish the two fields from each other and underscore the importance of not grouping all medical specialties into a single category. The data collected from the combat medic FEA will be leveraged to provide recommendations optimizing SBT's utility and effectiveness. This paper presents some of the key findings from the FEA to include data analysis and recommendations for future work.

BACKGROUND

The Army Nursing Project (2012-2013)

The ubiquitous application of SBT throughout military and medical domains requires intentional and systematic evaluation of use and effectiveness. In 2012-2013, a Human-Systems Integration (HSI) informed FEA was conducted to examine best practices and gaps in Army nursing medical simulation training systems. The FEA focused on the following critical factors in training situations: KSAs of targeted learners, user perceptions of system interactions, and efficacy of instructional delivery methods (Bockelman, Julian, Nolan, & Sotomayor, 2014). The findings from this study highlighted several major challenges in nursing training and SBT technologies; chief among them was a concern with development of training scenarios. From the Army nurses FEA, researchers provided recommendations to address the identified barriers, including the development of a shared repository of nursing scenarios and the development and/or the implementation of a simulator specifically for training unique nursing skills (e.g., the critically ill with a wide range of diseases and injuries). The present work expands the research to examine best practices and potential gaps in 68W training. The researchers applied the same FEA methodology employed in the Army nursing study to examine the unique use of simulation training for Army medics. The purpose was to collect FEA data that could inform medic SBT recommendations.

Army Combat Medics

Among the military staff, the medical specialties are responsible for, and relied upon to respond to military action worldwide. Often, they must attend to and execute medical tasks in harsh environments, with meager warning, and for an unknown period (De Lorenzo, 2005). Army combat medics focus on immediate care to casualties at the point of injury on the battlefield (Sotomayor, Mazzeo, Hill, & Hackett, 2013). In the civilian world, medics focus on the "golden hour," assisting the patient with care in the first hour. In contrast, combat medics are trained to focus on the "platinum 10 minutes," where the combat medics provide immediate lifesaving care.

To ensure readiness, soldiers must complete 16 weeks of Advanced Individual Training (AIT) after completion of Basic Combat Training (BCT). Training includes a variety of learning environments such as lectures, demonstrations of hands on practices, SBT, and scenario-based field exercises (Chapman et al., 2012; Rice, Marra, & Butler, 2007). During AIT, soldiers must complete and pass the Emergency Medical Technician-Basic (EMT-B**)** course, which is a six-and-a-half week course that renders healthcare and provides Cardiopulmonary Resuscitation (CPR) certification, allowing graduates to register as EMTs. Soldiers then complete nine-and-a-half weeks of tactical medicine training, which includes Tactical Combat Casualty Care (TC3) fundamentals (Chapman et al., 2012). TC3 is the pre-hospital care rendered in a combat environment. Training TC3 fundamentals has been proven to be highly effective in lowering casualties in conflicts (Sotomayor & Proctor, 2009).

TC3 provides medics with tools needed to perform pre-hospital care in tactical environments. Tactical medicine training consists of didactic training (classroom training/lecture), skill-based procedural training (part-task trainers), and scenario-based training (life-sized patient simulators) (Rice et al., 2007). This multifaceted training approach is designed to develop overall core skills required for combat casualty care (Chapman et al., 2012). Once tactical medicine training is complete, combat medics are tested on their overall knowledge of skills during two weeks of situational and Field Training Exercises (FTXs). During FTXs, medics are tested on critical skills under extreme simulated combat situations. Soldier medics must pass both the written and field exercises to complete training (Allen, 2011; Parsons, 2010).

Table 1. Current combat medic training program

Course	Duration	Description
EMT - Basic Course	6 ½ weeks	Pharmacology, wound care, medical documentation sick calls, mental health care training, behavioral health emergencies, battle mind resilience training, and depression recognition/prevention, to result in assessment/certification for National Registry of Emergency Medical Technician and CPR certification.
Tactical Combat Casualty Care (TC3)	9 ½ weeks	TC3 fundamentals, pre-hospital care to prevent casualties in a combat environment, combat casualty evacuation, treatment such as; tourniquet use, hemostatic agents, surgical airways, needle chest decompression (NDC), and IV training, and two weeks of FTX and assessments.

Training drills conducted by the military are progressively including more simulated technologies (Erwin, 2000). SBT technologies allow trainees hands-on practice and can enhance cognitive readiness training transfer into real world situations. Such technologies can improve and build upon trainees' KSAs (Gaba, 2004). SBT, along with scenario-based training, have become major components throughout the phases of combat medic AIT, shown in Table 1. SBT technologies are used throughout training in a crawl, walk, run method, starting with lower fidelity using single task-scenarios (e.g., IV part-task trainers) and then progressively moving to advanced human-patient simulators with full clinical scenarios. Having appropriate initial and sustainment training for combat medics with updated medical equipment, scenarios, and simulation technologies is essential for increasing real-time performance (Fowler, Smith, & Litteral, 2005).

Many studies have shown SBT technologies enhance training (Cohn et al., 2013; Moses, Magee, Bauer, & Leitch, 2001) and skill outcome of combat medics (Allen, 2011; Estock, Alexander, Gildea, Nash, & Blueggel, 2006), but there is still an outstanding need for standardization throughout military medical training and a deficiency of direction in building systems that best support training specific skills. Table 2 presents general simulation system categories and examples of simulation technologies used in military medical training today.

Table 2. The six simulation categories

Simulation System	Description	68W Example
Part-task Trainers	Simulate one part of a medical environment, usually a specific part of the body. Some models are animated, but they typically do not respond appropriately to users' actions.	NCD, tourniquet trainers, IV trainers, airway management trainers
Computer-Based Systems	CBTs train decision-making skills using a computer interface. The programs are used for independent, learner-centered training, and typically provide a limited simulation of a specific medical topic and offer automatic feedback.	STATcare
Virtual Reality and Haptic Systems	These are more complex computer-based simulations that include specialized input devices (e.g., laparoscopic handles) instead of a standard keyboard and mouse. Typically, the special device provides resistance, giving the "haptic" feel of pushing against bone, skin, or tissue while the virtual procedure is displayed.	CAREN (computer assisted rehabilitation environment) system
Standardized Patients	Standardized patients consist of human actors playing the roles of ailing patients. Standardized patient actors can be combined with part-task trainers (e.g., a simulated arm that can be sutured), so that the trainees can practice communication and performance skills in combination.	Role-players, trainees, and faculty
Integrated Simulators	They combine computerized control and feedback with responsive physical models (typically mannequins) that can be connected to monitoring devices. The most advanced versions can accurately replicate many bodily functions such as breathing and bleeding. These vary along a continuum from low to high fidelity.	SimMan 3G, MATT®, Rescue Randy
Simulated Environments	Combine several of the previous techniques into realistic settings and typically consist of pre-scripted training scenarios, actors, props, full-sized integrated simulators, and monitoring devices (e.g., video and audio recording). These scenarios allow students to integrate all of their skills and practice working under non-ideal conditions.	Mock villages/towns, market places, houses, and outdoor training lanes

Front-End Analysis of Combat Medic Training

To conduct the FEA, four 68W training locations were identified for data collection. Each location retains standardized equipment and Program of Instruction (POI) standards, although execution of training varies in some respects by facility. Data was captured at the following locales:

- **Medical Simulation Training Center (MSTC)**
  Fort Indiantown Gap, Pennsylvania | Fort Lewis, Washington
  MSTCs were created to deliver effective medical training with a standardized training platform for both classroom and simulated battlefield conditions to prepare soldiers for the application of medical interventions under combat conditions. The goal of MSTCs is to provide and conduct standardized medical training for medical and non-medical personnel. These simulation centers offer courses that teach life-saving techniques based on TC3 such as: Combat Lifesaver Course, Combat Medical Advanced Skills sustainment course, Basic Life Support CPR, EMT, and an EMT Refresher course (Kramer, 2009).

- **Medical Battalion Training Site (MBTS)**

Fort Indiantown Gap, Pennsylvania
The MBTS facility provides real-life battlefield simulated training for combat medics. The site is equipped to incorporate realistic sights and sounds during training that includes mass casualty scenarios, Military Operations on Urban Terrain (MOUT) training, and litter obstacle courses. Scenario video and audio is captured for use in comprehensive After Action Reviews (AARs).

- **Department of Combat Medic Training** (**DCMT**)
  Joint Base San Antonio - Fort Sam Houston, Texas
  DCMT serves as the proponent for the 68W Health Care Specialist and the Army Emergency Medical Service (EMS) (Chapman et al., 2011). DCMT trains over 8,000 new medics every year during AIT. The school is equipped with one of the largest collections of human simulation systems and has integrated technology into its teaching. DCMT also offers simulated environments to sharpen trainees' skills in a mock hostile environment (Baker, 2008).

METHODOLOGY

The research team visited the training sites to collect data necessary for the identification of best practices, potential gaps, and simulation opportunities. At each site, opinions and insights were solicited regarding combat medic SBT. The team conducted focus groups, key leader interviews with site leads, and collected feedback via surveys. Surveys were adapted from the previous U.S. Army nursing FEA effort to quantitatively compare and contrast results between disciplines and capture qualitative free response.

Participants

Participants were recruited from each training site. All participants (n = 60) were given an overview of the purpose of the FEA, instructions for their participation, and directions for completion of all surveys. A subset (n = 47) of the participants engaged in focus groups to discuss specific topic areas. Additionally, the research team conducted six key leader interviews, including site leads at each of the installations.

Materials

- **Demographics survey**
  - participant's role, service and rank, years of service
  - healthcare education level
  - combat medic instructor years of experience

- **Simulation reaction survey**
  - opinions, past experiences, and recommendations regarding medical SBT technologies
  - specific simulator types, relevancy of the simulator to the learning objectives, ability to learn advanced problem solving skills, opinion of any associated technology problems, usability, appropriateness for expertise level, usefulness for assessment, and the desire to use the simulator type again

- **Army Medic KSAs**
  - specific KSAs importance to 68W

- **Core Training for Combat Medics**
  - core training techniques and procedures
  - usability of each type of simulation category

Procedure

Surveys

Participants were asked to complete a paper-based survey asking about their opinions, past experiences, and recommendations regarding medical SBT technologies. Participants first completed the demographics questionnaire, followed by the simulation reactions survey. Responses were scored, coded, and analyzed by the research team.

Focus Groups

Overall, 47 participants across multiple sites contributed to focus group discussions. Group size was unrestricted and based on the availability and willingness of participants. Sessions lasted between 30 minutes and one hour. Participants responded to semi-structured interview questions and engaged in dialogue with the researchers.

Informal Interviews

When available, researchers solicited information from key leaders at each facility. Typically, these individuals were site leads and were able to provide continuous information throughout the site visits.

Training Observation

Training center personnel provided tours of each facility, and explained simulator capabilities, training resources, and typical training regimens. The researchers observed training scenarios conducted in a MOUT environment utilizing role players, SBT, and support personnel as part of the trainees' final assessments. The researchers documented how the instructors interacted with trainees during the scenarios, their use of KSA rubric-driven checklists for assessment, and how they conducted their AAR to evaluate the trainee's performance.

RESULTS

Demographics

The participant pool was comprised of 60 personnel across the four data collection sites. Researchers captured key demographic features, such as military and academic experience, in order to better understand the characteristics of the selected population. Of the 60, 41 were classified as NCOs (E4-E6), 16 as Senior NCOs (E7-E9), along with 1 Field Grade officer (O4-O6), 1 Company Grade officer (O1-O3), and 1 Enlisted Soldier (E1-E3). With respect to active years in service, approximately 92% of participants responded that they have been serving for 7 or more years. However, when asked how many years they have been a combat medic instructor, the responses were less homogenous with 39% reporting less than a year of instructor experience, 22% with 1-3 years, 10% with 3-7 years, and 29% with more than 7 years of experience (Figure 1). Lastly, of the participants who responded (n = 55), 18% hold a Bachelor's degree (or higher) in the field of healthcare, 33% hold an Associates in a healthcare related field, and 49% have some technical training, but do not hold a formal degree or certificate. As the demographics showed shared characteristics of educational and professional experience, the following quantitative results have been aggregated to most accurately capture the features of 68W training.

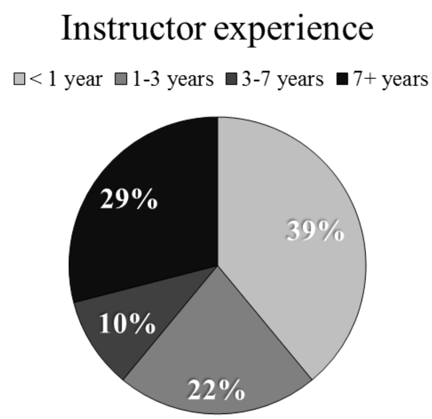

Figure 1. Instructor experience in years

On core training

Participants were asked to rate the usability of each simulator type for each of the combat medic's core training topics. For this particular questionnaire, usability was noted and defined as how effective, easy to use, and how subjectively acceptable the simulator is for the given task. Table 3 shows the results of these questions.

Table 3. Percentage of participants that found each simulation category "usable" or "extremely usable" for a component of core training. Responses over 50% are shaded.

Core Training for Combat Medics	Part-task trainers	Computer-based training	Virtual reality systems	Standardized patients	Integrated simulators	Simulated environments
Combat Casualty Assessment	**36**	**13**	**10**	**65**	**70**	**72**
Tourniquet	**55**	**8**	**7**	**57**	**70**	**67**
Hemostatic agents	**35**	**7**	**8**	**50**	**67**	**63**
Needle Chest Decompression	**60**	**12**	**10**	**28**	**70**	**63**
Surgical airway	**60**	**12**	**15**	**28**	**70**	**63**
King LT airway	**58**	**13**	**10**	**25**	**62**	**57**
IV & Fast-1	**57**	**10**	**12**	**43**	**60**	**57**

Note. Numbers represent percentages.

The information presented below in Figure 2 compares the percentage of participants that reported experience using each simulation type. The same questionnaire was used for the Army nursing effort, which enabled a comparison across specialties to extend to the current combat medics work. Results are shown in percentages as the number of participants in each study differed with 60 combat medic participants and 105 nursing participants.

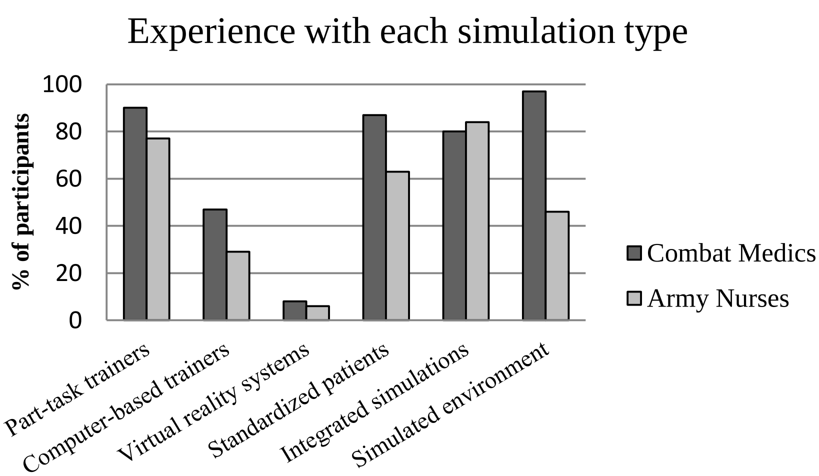

Figure 2. Comparing combat medic and nursing experience with simulation categories

DISCUSSION

One of the goals of the present work was to find out what type of SBT is effective for training the skills required of 68Ws. The research team solicited opinions from SMEs at multiple training facilities, the majority of which are seasoned combat medics. With the U.S. on a war footing for the past decade or so, the current combat medic instructors have real-world combat experience with a myriad of old and new threats. The opinions of these SMEs are important to capture as they may provide the best assessment of SBT technologies with respect to what medics will actually experience in theater.

Quantitative Results

First, with the overwhelming emphasis on SBT in the combat medic specialty, it was important to collect feedback from actual practitioners regarding the effectiveness of the training technologies. The Core Training for Combat Medics questionnaire inquired specifically about core training and asked each instructor to rate how usable or effective each type of simulation was for training. The results from Table 3 highlight the need (or want) for hands-on, realistic, and immersive training. Although standardized patients are ranked as effective for some of the tasks, due to the requirements of the 68W specialty, there are many types of training that they simply cannot perform on a live patient. For this, instructors looked to the part-task trainers and integrated simulators. The combination of all of these, simulated environments, was the highest ranked as it typically provides for the most realistic experience. Although many of the other simulation categories can be useful in training, one of the defining elements that set combat medics apart from other military specialties, such as the Army nurses, is the need for care under extremely stressful conditions, which simulated environments provide. This is also seen in Figure 2. When comparing Army nurses to combat medics, the largest difference is in the simulated environments category. Nurses do have a stressful job, yet even the most "intense" environment they might experience cannot compare to the battlefield care under fire provided by medics. Additionally, to further emphasize the reliance on SBT for medics, they reported having more experience with almost every simulation type versus nurses.

Although the simulated environments generally require the most resources to set up, they remain the most effective for training the majority of combat medic core tasks. Less resource intensive Computer-Based Training (CBT) and Virtual Reality (VR) training consistently ranked low in terms of effectiveness, and may be an opportunity for future improvement with the current austere defense spending environment. In terms of experience (Figure 2), Army nurses reported similar trends with respect to CBT and VR training, with neither specialty using either very much. Expectations for usage of each simulation type mirror previous data, as seen in Figure 3. Specifically, the question asked participants "How often do you use" each simulation type.

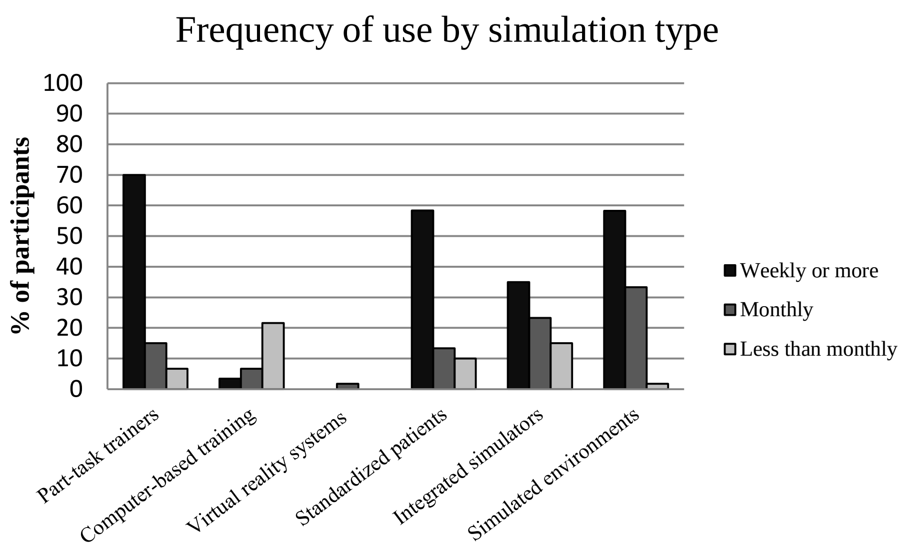

Figure 3. The percentage of use/frequency reported by simulation category

The easier to setup, low resource, part-task trainers are frequently used on a weekly basis. With the reported low confidence that CBT or VR training can effectively train combat medic tasks, it is not surprising that their usage in training is also very low. Less than 10% of participants reported using CBT or VR training on an even monthly basis. In contrast, standardized patient and simulated environment usage ranked much higher with approximately 60% reporting weekly or more usage. These findings may reflect the ease-of-use and availability of role players, as instructors can pull trainees to fulfill those roles in real time. These findings also reflect the trade-offs required by simulation type. For example, simulated environments are high-return (needed to practice essential skills), so investment in set-up is worthwhile.

Approximately 35% of respondents reported using the more complex integrated simulators on a weekly basis. The lower usage of these may attributed to the sophisticated setup and scenario authoring required. Additionally, some of the integrated simulators may be too complex for what is required of combat medic training. The need for a "middle-ground" between advanced and complex simulators and a weighted rugged dummy to be carried around was brought up multiple times over qualitative focus groups and interviews.

Qualitative Results

Although combat medics and nurses share commonalities under the military medical occupational specialties, there are also major differences. Both training programs require medical KSAs and military functions. However, these two domains have unique characteristics and mission requirements (see Table 4). Generally, the medic population will be deployed in theater with fewer hours of training than their nursing counterparts (Bockleman et al., 2014). This is in contrast to Army nursing conditions, which tends to be more diverse and within a continuum of care. Combat medics undergo 10 weeks of BCT and 16 weeks of AIT rendering EMT-B certification, while Army nursing positions require a Bachelor's degree in nursing from an accredited school and a nursing license. Usually, combat medics training is heavily focused on performing in austere conditions, while nurses training may be conducted under sterile and resource-satisfactory conditions (Smith, 2008). Table 4 provides a summary description of some of the differences in training, resources, and requirements between the specialties. These, and other findings, are considered in developing recommendations within the HSI organizational framework in the final report.

Table 4. Comparing and Contrasting the two Military Medical Specialties-Army Nurses and Combat Medics

	Combat Medic	Army Nurse
Major Duties	Soldiers first, then medics. Provide emergency medical treatment, limited primary care, force health protection, and evacuation	Addressing all aspects of patient care
Training	Completion of 68W10 Healthcare Specialist Course	Completion of Basic Officer Leadership Course
Skills	Physical assessment of acute injuries, limited primary care, advanced level skills from venipuncture to intraosseous fluid replacement and chest tube insertion, some pharmacology	Provide care for injured or ill soldiers during war time and wherever stations, implementing critical care intervention in a field environment, managing the treatment of a critical care patient in a military health care facility
Education/Certification	CPR, EMT-B	Bachelor degree in nursing & current nursing license
Environment of Care	Austere conditions	Resource-satisfactory conditions
Resources	What medics are able to carry in their A bag	Resources of the medical facility
Duration of Care	Platinum 10 Minutes	Continuum of care

Like the previous work in understanding Army nursing training, the research on combat medics used an HSI-informed FEA approach for data collection to ensure that expert reports and observations can be applied using a consistent methodology. This method helped the research team identify shared training gaps and simulation opportunities for both domains, while isolating unique field-specific gaps and simulation opportunities as well. The research team found multiple reoccurring gaps between the two professions. These gaps are in alignment with previous work in 68W simulation research. For example, Sotomayor and colleagues (2013) asserted that compromised fidelity in medical simulation technologies could pose challenges for transfer of learning to the battlefield. The research focused on developing advances in material technologies and animatronics to overcome the current barriers. The present FEA compares and contrasts findings like these within the context of Army nurses and medics.

Both Army nurses and 68W interviewees expressed the need to have available mannequin simulators that replicate unique populations such as, female and culturally sensitive groups (Marraffino et al., 2013). Most mannequins used for nursing and medic training consist of average-sized white males. Another major concern between both medical groups interviewed, is the need to write simulation into training curriculum. Schatz et al (2013) found that several interviewees recommended including SBT in medical curricula, linking scenario files and other SBT tools into a

POI distributed through the U.S. Army Training and Doctrine Command (TRADOC). For combat medics, instructors also showed concern with the lack of connection between available simulation technologies and curriculum. Medic instructors indicated concern with simulators appropriately training 68W curricula. Commercial simulation technologies yield accepted industry standards for medical practice but do not incorporate appropriate landmarks for training the combat medic skill set, which can ultimately induce negative training. When asked about noticeable gaps in medical training, nursing and medic SMEs offered their view, specifically with airway trainers. Numerous nursing and medic personnel stated that airway simulators are stiff and nonflexible, and felt such issues may produce negative training outcomes, due to lack of realism.

The research team documented several concerns solely from combat medic instructors and SMEs. Combat medic instructors across all visited sites recommended making simulators and mannequins that are "soldier proof." The reliability and ruggedness of simulators were a reoccurring concern. Maintenance and time consumption of high fidelity mannequins puts a strain on both life-cycle cost effectiveness and instructors. Hundreds of students cycle through training sites like DCMT. Providing mannequins that are rugged enough to train students in trauma care situations (i.e., "care under fire") where the soldier medic must drag the mannequin out of fire to render care, is important to 68W training. A major concern expressed from multiple MSTC Fort Lewis SMEs, was the need to eliminate and/or decrease the amount of scenario injects during training and assessment. Fort Lewis personnel expressed the importance in removing any instructor/student scenario injects, where the instructor must give the trainee cues like, pulse, equal or unequal rise and fall of chest, or injecting sounds (e.g., coughing and snoring). This is due to a lack of mannequins that appropriately simulate 68W core skills. For example, the research team observed many training sites using the Rescue Randy mannequin for SBT. These mannequins are low fidelity with no "bells and whistles," but are continuously used because of their durability. While the Rescue Randy's are durable and cost efficient, the instructor is responsible for providing all scenario feedback points to the trainee. Scenario injects are time consuming to prepare, take away from the fidelity of the situation and assessments, and often provide shortcuts for trainees.

The results as reported above suggest practical enhancements to the usability and effectiveness of SBT for combat medic training.

FUTURE DIRECTION

The conclusions and takeaways from this first phase of the multi-year, overarching program of study is to leverage the results from this HSI-centric FEA to inform the next phase of the project. The following preliminary recommendations may be considered for future work. First, an analysis should be undertaken to define requirements for the design and use of Low-, Medium-, and High-Fidelity SBT that would be effective for ICU nurses as well as combat medic training. Second, further research should include scenario authoring best practices to develop recommendations for creating a "wizard" to enhance and support development of scenario content, storyboards, presentation materials and training assessments, as well as takeaways for the trainees to reference once training has concluded. Third, HSI-driven analyses should be conducted to identify current gaps, inefficiencies, and opportunities to improve upon and enhance training efficiency. Study findings will help provide guidance to decision makers, instructional designers, and science and technology efforts in defining critical variables and links to performance outcomes for the right mix of fidelity and insertion points in the training continuum for a more effective ROI. The present study has conclusively presented evidence of utility and effectiveness of SBT in combat medic training and informed areas that need more study and support.

ACKNOWLEDGEMENTS

This work was supported by ARL-HRED STTC. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of ARL, the Army, or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation hereon.

REFERENCES

Allen, C. M. (2011). *Bleeding Control Using Multiple Amputee Trauma Trainer in Medical Simulation: Comparison of Movement Versus Non-movement in Training* (Doctoral dissertation, University of Central Florida, Orlando, Florida).

Bockelman, P., Julian, D., Nolan, M. & Sotomayor, T. (2014). Practical human-systems integration methods for medical simulation lifecycle costing. *Proceedings of the MODSIM World Conference and Expo 2014.* Hampton, VA.

Chapman, P.L., Cabrera, D., Varela-Mayer, C., Baker, M., Elnitsky, C., Figley, C., Thurman, R.M., Lin, C., & Mayer, P. (2012). Training, deployment preparation, and combat experiences of deployed health care personnel: Key findings from deployed U.S. Army combat medics assigned to line units. *Military Medicine*, Vol. *177* (3), 270-277.

Cohn, J. V., Combs, D. J., Anglero Jr, A., Johnson, B. R., Rozovski, D., Eggan, S., & O'Neill, E. (2013). Medical Modeling and Simulation Based Training Return on Investment Decision Model. In *HCI International 2013-Posters' Extended Abstracts* (pp. 144-147). Springer Berlin Heidelberg.

De Lorenzo, R. A. (2005). How shall we train? *Military medicine*, *170*(10).

Erwin, S. (2000). Simulation of Human Behavior Helps Military Training Models. Retrieved March 1, 2014, from http://www.nationaldefensemagazine.org/archive/2000/November/Pages/Simulation_of7190.aspx

Estock, M. J. L., Alexander, D. A. L., Gildea, D. K. M., Nash, C. M., & Blueggel, L. B. (2006). A model-based approach to simulator fidelity and training effectiveness. In *The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC)* (Vol. 2006, No. 1). National Training Systems Association.

Fowler, S., Smith, B., & Litteral, C. D. J. (2005). A TC3 game-based simulation for combat medic training. In *The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC)* (Vol. 2005, No. 1). National Training Systems Association.

Gaba, D. M. (2004). The future vision of simulation in health care. *Quality and Safety in Health Care*, *13*(1), i2-i10.

Kramer, D. (2009). Fort Lewis MSTC teaches soldiers how to save wounded comrades. Retrieved from: http://www.army.mil/article/17842/Fort_Lewis_MSTC_teaches_Soldiers_how_to_save_wounded_comrades/

Marraffino, A., Schatz, S., Tanaka, A., & Nolan, M. (2013). *Army Nursing Simulation: Front-End Analysis for Army Nursing Simulation.* Orlando: DSCI MESH Solutions.

Moses, G., Magee, J. H., Bauer, J. J., & Leitch, R. (2001). Military medical modeling and simulation in the 21st century. *Studies in health technology and informatics*, *81*, 322.

Parsons, D. (2010). *Edition CALMS Combat Lifesaver Course: Student Self-Study.* Fort Sam Houston, TX.

Rice, B., Butler, J., & Marra, D. (2007). *Neuro-Cognitive Assessment, Symptoms of Attention Deficit and Hyperactivity Disorder, and Soldier Performance During 68W Advanced Individual Training*; ARL-TR4292; U.S. Army Research Laboratory: Aberdeen Proving Ground, MD.

Schatz, S., Marraffino, A., Allen, C., & Tanaka, A. (2013). Human–systems integration, simulation, and the nursing shortage. *Proceedings of the International Symposium of Human Factors and Ergonomics in Healthcare*, *2*(1), 135–142.

Smith, K. K. (2008). Critical care nursing in an austere environment: *Critical Care Medicine*, *36*(Suppl), S297–S303.

Sotomayor, T., & Proctor, M. (2009). Assessing combat medic knowledge and transfer effects resulting from alternative training treatments. *Journal of Defense Modeling and Simulation: Applications, Methodology, Technology 6*(3) 121-134.

Sotomayor, T., Peters, R., Riddle, D., & Parsons, D. (2007). Designing and evaluating the transfer of learning through a game-based simulation for combat medics. *Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC),* Orlando, FL.

Sotomayor, T., Mazzeo, M., Hill, A., & Hackett, M. (2013). Severe Trauma Stress Inoculation Training for Combat Medics using High Fidelity Simulation. In *The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC)* (Vol. 2013, No. 1). National Training Systems Association.