ACCELERATING DEVELOPMENT OF SIMULATION-BASED MEDICAL SKILL TRAINING PROGRAMS: A COMPARATIVE EVALUATION RESEARCH STUDY

A Dissertation

presented to

the Faculty of the Graduate School

at the University of Missouri-Columbia

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

---

by

CHRISTINA L. STEPHAN

Dr. Kristofer Hagglund, Dissertation Supervisor

DECEMBER 2013

The undersigned, appointed by the dean of the Graduate School,

have examined the Dissertation entitled

ACCELERATING DEVELOPMENT OF SIMULATION-BASED MEDICAL SKILL TRAINING PROGRAMS: A COMPARATIVE EVALUATION RESEARCH STUDY

Presented by Christina L. Stephan

A candidate for the degree of

Doctor of Philosophy

And hereby certify that, in their opinion, it is worthy of acceptance.

_____

Kristofer Hagglund, PhD, ABPP (Chair)

_____

Stephen L. Barnes, MD FACS

_____

Sue Boren, MHA, PhD

_____

Gregory L. Alexander, PhD, MHA, RN, FAAN

_____

Annette Sobel, MD, MS

ACKNOWLEDGEMENTS

I am sincerely thankful for the support and guidance provided by members of dissertation committee:

- Kristofer Hagglund, PhD, ABPP (Chair)
- Stephen L. Barnes, MD FACS
- Sue Boren, MHA, PhD
- Gregory L. Alexander, PhD, MHA, RN, FAAN
- Annette Sobel, MD, MS

I especially wish to thank the study participants; without whose committed participation this study would not have been possible, as well as members of the Combat Casualty Training Consortium who designed and executed the project:

- PI, CCTC: Stephen Barnes, MD
- PI, Cholinergic Crisis Management Study: Alex Bukoski, DVM, PhD, DACVA
- Research Fellow, Chris Cooper MD, Rindi Uhlich
- IVIR – Moira Hendricks PhD, Emily Burns, PhD, Nadine Baez: Development of Surveys and Questionnaires.
- Sheldon Simulation Center staff members

I would also like to acknowledge Chi-Ren Shyu, PhD, Director of the University of Missouri Informatics Institute, and the staff of MUII who provide leadership and sponsor the Health Informatics Doctoral Program.

This project is sponsored by the Department of Defense (DOD) Telemedicine and Advanced Technology Research Center (TATRC); Contract No.W81XWH-11-2-0155 # 11322004.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

A shift in Military utilization of Live Tissue Training (LTT) to Simulation-based Training (SBT) for combat casualty care training programs is currently underway. While each has been reported to be effective, there is little high quality research comparing traditional LTT with SBT learning outcomes.

The shift in training methods is partly in response to increased regulatory requirements, higher costs and public sentiments. The benefits of training with a live anesthetized animal are an immediate physiologic feedback to treatment interventions and practice in 'real-world', high-stakes continual patient assessment and decision making. Simulation-based training offers opportunities for deliberate practice and skill mastery without the sense of urgency or 'real-world' life and death outcomes the trainee will face in combat casualty care. The paucity of experimental evidence demonstrating that the two types of training are comparable has contributed to slow adoption of SBT technology for resuscitation procedures, particularly in combat casualty training.

This study entails the direct comparison of LTT and SBT in a randomized, pre-test post-test experiment. Changes in trainee knowledge, psychomotor skill, and self-efficacy are assessed using established measures. Stress and emotion are known to play a role in performance and learning. This study also investigated the use of sweat measurement as a possible indicator of a stressful response to the training situation. This was accomplished by measuring changes in skin impedance during didactic and hands-on training. Following completion of the training session, training participants completed a survey regarding perceived

value of the training. An independent evaluation of the study was conducted by the University of Central Florida's Institute for Simulation and Training.

Statistical analyses showed no significant difference between the training groups in any of the learning measures. The change in electrodermal activity was non-significant between the two training groups. Participant evaluations revealed strong belief among trainees that LTT was of greater value to the training participants, however, participants suggested that LTT should be continued for combat casualty care training while SBT could be useful to other groups of learners. A more limited use of LTT would address the concerns regarding the use of live tissue.

The comparison of learning outcomes in this controlled study provides new evidence to support further integration of SBT in combat casualty training. The study results will inform trauma education planning so that the most effective training methods available for military personnel preparing for combat casualty care can be utilized.

Key words: simulation-based training, medical education, pediatric intubation, live tissue training, combat medicine

1.0 INTRODUCTION

The University of Missouri Combat Casualty Training Consortium (MU-CCTC) was established to accelerate research and development of Simulation-Based Training (SBT) for combat casualty care training for military personnel. This research entailed a direct comparison of Live Tissue Training (LTT) with SBT training outcomes. Learning outcomes measures based upon educational objectives developed from established practices were utilized to provide clarity on the strengths and weakness of SBT training compared to standard LTT. Current studies supporting the sole use of animals for medical education and training are rare. In addition, there is limited information documenting either the animal model or simulation technology as a superior method for critical care medical skills. Thus, scientific evidence to support the use of either method is lacking [1].

The current research has significant clinical implications because advancements in military critical care are adopted into civilian trauma practice, save lives and lead to extensive reassessment of training methods [2, 3, 4]. Battlefield injuries are challenging to manage, even for experienced clinicians. Tradition holds that the best way to train combat health care providers is through repeated practice. The use of live animals in medical training is an accepted component of that experience, but currently has been made more difficult to provide due to increased regulatory requirements, public pressure against live animal use, and

increasing costs. The benefits of training with a live anesthetized animal are an immediate physiologic feedback to treatment interventions and practice in continual patient assessment and the pressure of high-stakes decision making for trainees. As reported by Byrne and colleagues, live tissue training can evoke an emotional response with a profound sense of urgency to achieve fast and accurate diagnosis and effective treatment [5]. SBT offers opportunities for deliberate practice, and a mobile training platform which can be conducted "anywhere, anytime." This study contributes a direct comparison of the learning outcomes associated with SBT compared to LTT. The study hypothesized that simulation-based medical education would be associated with larger increases in learning outcomes and arousal due to the opportunity for repeat practice with an interactive human anatomic model.

Significance

The paucity of experimental evidence has been a significant barrier in further adoption and use of SBT technology for resuscitation procedures, particularly in combat casualty training. The Combat Casualty Training Consortium (CCTC) was established to conduct a direct comparison of SBT and LTT. The research project used an established technology development approach [6]. It is expected that this work will accelerate development and adoption of SBT. The results from this study will be used to better understand the differences in learning outcomes between training with life tissue compared to simulation-based training and are expected to inform development of simulators in the future. Combat casualty care during war and conflict has prompted advances in treating casualties [7].

Survivability of battlefield casualties is linked to the advanced training for those providing care at the point of injury [8]. Further advances in supporting technology enhance training tools and can continue to improve upon casualty survival rates [9,10].

Combat casualty care has been conducted with modeling, simulation, live anesthetized animals, and patient actors. Due to the rigorous demands of providing combat casualty care, training typically involves a combination of methods that foster knowledge acquisition, practice of psychomotor skills, and adaptation to the affective aspects of performance [11]. It is well established that training with a multimodal approach is effective [12, 13, 14].

The current controlled study provided evidence of the differences and effect on training outcomes by making a direct comparison of outcomes for trainees who worked with live anesthetized animals compared to those who had simulation-based training for pediatric intubation. The results contribute clarity to the differences between the two types of training, and result in a better understanding of the strengths and weaknesses of each modality.

While the training process is similar for each of the military services, there is not a standardized approach. It is anticipated that the standardized educational objectives and assessments which were designed and tested by members of the Combat Casualty Consortium, will further improve development of learning practice and training modalities in combat casualty care. The results of this work have produced a more comprehensive and standardized method of training and

performance assessment. This will measurably affect the military medic training concepts and modalities of the future.

Specific Aims

The current study entailed the direct comparison of LTT and SBT in a controlled, randomized, pre-test post-test experimental design. Changes in trainee knowledge, psychomotor skill, and self-efficacy between groups were compared. Because stress and emotion are known to play a role in performance and learning, the use of sweat measurement as one indicator of the level stress experienced by trainees was explored. This was accomplished by measuring changes in skin impedance during didactic and hands-on training. Trainee satisfaction and self-report of program effectiveness following completion of the training session was also considered important. Therefore, all trainees completed a survey regarding the perceived value of the training they received. The University of Central Florida's Institute for Simulation and Training conducted an independent interim evaluation of the study results.

Aim #1: To determine if there were significant differences in learning outcomes between a group trained with simulation-based training compared to a group trained with a live animal model.

A. To determine if there was a significant difference between groups in changes in knowledge assessment scores.

B. To determine if there was a significant difference between groups in changes in psychomotor scores.

C. To determine if there was a significant difference between groups in changes in self-efficacy scores.

D. To determine if there was a significant difference between groups in changes in skin impedance measure

Aim #2: To determine if there was a significant difference in the perceived value of the training between a group trained with simulation-based training compared to a group trained with a live animal model.

2.0 LITERATURE REVIEW – PEDIATRIC INTUBATION AND SIMULATION-BASED TRAINING

Simulation-based training theory is drawn from a combination of models and considerations, including human factors modeling, instructional design, adult learning and trainee engagement. These variables are described in the section below to lay the groundwork for this research project. Next, a literature review of prior work specifically related to simulation-based training, pediatric intubation, and performance assessment was conducted. The prior research studies on topics germane to the current are reported in the section to follow.

Human Factors Considerations in Simulation-based Training

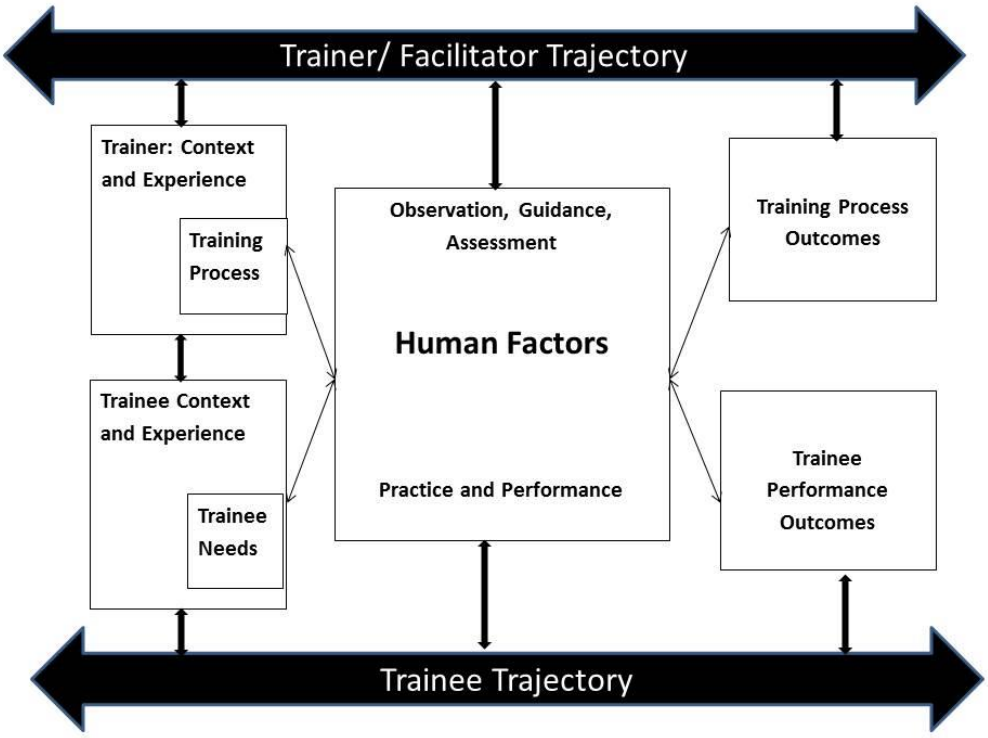
Simulation-based training technology assessment should be shaped and informed by a systematic approach. The approach should provide structure and guide inclusion of important elements that contribute to the quality of the training interaction and learning outcomes.

A “human factors approach” [15] adapted from Alexander, combined with elements of a socio-technical framework [16, 17] was employed in this assessment. This model includes the following human factors elements: the trainer, trainee, training process, training modality or approach, and curriculum. It should be noted that both the trainer and the trainee perceptions and experience impact the training interaction. The trainer has considerable impact on the training process. It is also clear that trainee needs and prior experience have a significant impact on the system interaction as well. Human factors

considerations have been described by authors such as Alexander (2007) [18]. This framework links patient care processes, nurse and patient trajectories, and nursing and patient outcomes [19]. Adapted for this study, analogous components include the following categories: observation, guidance, assessment, practice, and performance. These elements are further described in the following sections because they relate to curriculum design. Finally, it must be acknowledged that the trainer and trainee engagement and performance are influenced by experience which encompasses beginners to experts. As described by Benner and colleagues (1992) regarding nursing skill development, beginner level trainees tend to focus on the immediate needs of the situation and apply rules and protocols to do so. Trainees who have competence in the skill scenario will recognize and adapt to the needs of the scenario when rules or protocols are insufficient. Competent trainees strive for mastery and can be skeptical of training methods with recognized limitations of the established protocol. Proficient trainees are better prepared to appreciate the changing situation more quickly and react accordingly. An expert trainee not only recognizes familiar scenarios, he or she will also be aware of his or her respective limitations in responding in the scenario [20]. In this way, the trainee's level of experience will contribute to shaping the training interaction. This model has been adopted in other areas involving assessment of technology and human interaction such as clinical decision support models [21]. McGaghie and colleagues (2005) reviewed simulation based medical education (SBME) and identified salient features of effective SBME, among which include that the goals

and tools need to match each other. In other words, adoption of the right training approach for a specific type of trainee, whether a novice or an expert, and the specific procedural skill is essential in delivering an optimized training experience.

Figure 1 Technology assessment and human factors framework (adapted from Alexander, 2007)



Training Methods

Training with simulation can range from low fidelity partial task trainers (such as a plastic model consisting of head and shoulders, or the oropharynx) to higher fidelity simulators [22] such as interactive virtual programs, [23] whole body

simulators, moulaged actors, and cadavers. The pediatric intubation study used a computerized full body child manikin. Training with live tissue was conducted using live anesthetized animals; in this case, the study utilized the ferret.

As described in Bloom's taxonomy of learning [24] emotions are a key aspect of learning [25, 26]. Training with emotionally realistic conditions increases the likelihood of memory for cognitive and psychomotor responses to execute reflexively under stressful conditions [27]. Conversely, excess stress can impede learning and performance. Ideally, training will involve an "optimal" level of tension which challenges trainees without impairing the learning process. This "sweet spot" [28, 29] on the learning and performance curve has been well described [30, 31] It is well established that training with a multimodal approach that combines approaches such as simulation, with other modalities, is effective. This has been used to train clinicians and non-clinicians for combat casualty training [32] and future events involving weapons of mass destruction and terrorism [33]. The combined training approach delivers a "systematic modification of behavior through instruction, practice, measurement, and feedback [34].

Simulation-based Training

The advantages of simulation are "permission to fail" without loss of life, opportunity for repetition and accurate human anatomy. Simulation-based training offers opportunities for deliberate practice and skill mastery and is an

effective mode of training for many medical skills [35, 36]. The disadvantages are lack of realism or “lack of presence,” lack of physiological response in real time, and likelihood of rapid technical obsolescence. The manikins give no appreciable realism or timely feedback on procedural technique or accuracy. Other missing elements in inanimate simulation-based training are urgency and critical reasoning skills needed to adequately assess a patient’s injuries and prioritize life-saving treatment [37]. Simulator technology continues to improve in life-like quality and response, but adoption continues to lag because some believe it does not provide an adequately realistic training experience for combat casualty care [38].

Live Animal Model Based Training

The use of live animals in medical training is increasingly difficult due to increased regulatory requirements [39] public pressure [40] public scrutiny [41], and legislative pressure to replace live animal trauma training with realistic alternatives [42]. Training with live animals can be associated with increased training cost [43]. Its use does not lend itself to repetitive training [44] and therefore can also limit training opportunities. If the animal expires, the training or test event is over until a replacement can be procured. These issues can negatively affect the quality of training and learning outcomes. It has been argued that the use of animals misguides students because the animals’ anatomy [45] is different from that of a human. Conversely, training with a live anesthetized animal provides trainees with the immediate physiologic feedback to treatment interventions. Training with a live animal provides exposure and

practice in continual patient assessment and decision making. Some military experts argue that the exposure to a living creature for medical trauma treatment has an essential psychological experience component that cannot be replicated by simulation [46] although this has not been proven. As reported by Byrne and colleagues, this type of training can evoke an emotional response with a profound sense of urgency to achieve fast and accurate diagnosis and effective treatment [47, 48].

Environment

It has been reported that the more realistic a virtual training environment is, the more likely it will evoke physiological responses similar to those evoked by the corresponding real environment [49, 50]. The training must prepare participants to make fast accurate decisions with decisive action despite very challenging circumstances. The participant may have little or no prior experience, and casualty lives are at stake. The environment is stressful, can be chaotic, and possibly hostile. The responder may also have to work with additional challenges, due to protective clothing [51, 52] and gear, and is further challenged to provide fast appropriate treatment despite a diminished sense of touch, smell, and vision associated with protective clothing [53], mask and respirator equipment [54, 55]. Combat casualty training strives to provide a challenging training environment to optimally prepare military personnel for the rigors of casualty care.

Adult Learning Theory

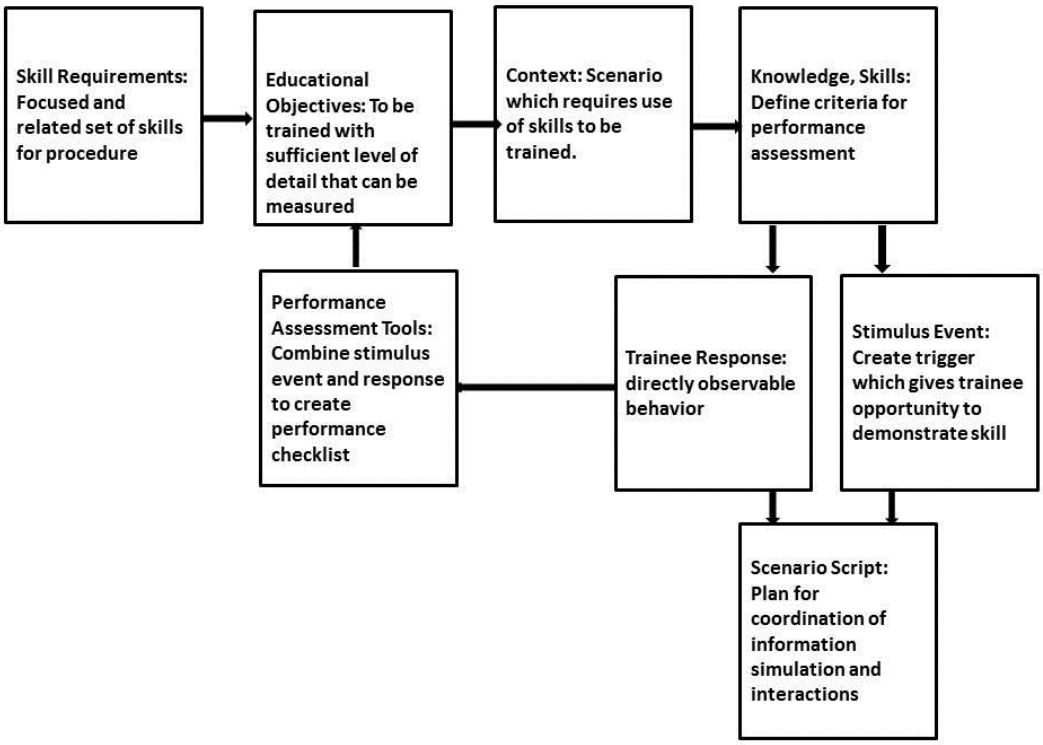
The instructional design used in this study draws from adult learning theory. The simulation-based training approach entails a guide-on-the side role; that is, 'facilitating but not leading' the process [56]. Adult learners are characterized by independence and autonomy in the learning process and take personal responsibility for learning activities and outcomes [57]. The military learner may have distinctive strengths and needs that set him or her apart from other adult learners. Often the military learner brings increased richness of leadership and communication experience as a result of military assignments. Military learners encountered in this study epitomize adult learners. They are self-directed and autonomous. They possess maturity and often have a significant record of professional responsibility and accountability [58]. The instructional design of this course accounts for the adult military learner.

Instructional Systems Design

Instructional systems design has been described by numerous educators for a variety of learning and training applications. Rosen, Salas, and colleagues (2008) have developed a process which incorporates eight essential steps to be developed for use in simulation-based training. The steps are generic across all simulation types and procedures and consist of the following steps. The first step is to develop skill requirements for a focused set of related skills for a procedure. Educational Objectives should be specified with sufficient level of detail that performance can be measured. A scenario which describes the context for the

simulation is helpful to get the participant oriented and focused to perform the procedure. Knowledge and skill criteria for performing the procedure should be specified. The stimulus event, or trigger, should indicate to the trainee the need to perform the trained skill. The desired trainee response should be described and be directly observable. The performance assessment includes a checklist which matches stimulus event and response to educational objectives [59].

Figure 2 - Instructional Systems Design Model for Medical Skills Training (adapted from Rosen, Salas 2008)



Performance Assessment

The performance assessment includes procedural skill assessment and knowledge assessment. Trainees' self-efficacy for specific skills was evaluated and recorded. The standardized curriculum was developed using an accepted curriculum design framework [60] for instructional systems design [61,62]

Accepted performance measurement documents and standards have been synthesized to create a standardized, cross-service consensus-based trainee

performance assessment system. The performance assessment system integrates four assessment components, including: 1) procedural knowledge, 2) execution of the procedure, 3) trainee confidence in performing the procedure; 4) course evaluation of the training experience. The automated, multi-dimensional performance assessment is also innovative because combat casualty training does not typically involve all these aspects of assessment. Both the curriculum and the performance assessment method were developed thru a consensus based decision making process by subject matter expert members of the University of Missouri Combat Casualty Training Consortium.

The assessment component of medical skills training for pediatric intubation is a necessary first step for evaluating the differences in training outcomes between the LTT and SBT. The comprehensive assessment is automated on a computer tablet device which enables a more focused efficient means of conducting the assessment while minimizing the need to have papers and materials in the training area. This approach also minimizes interruptions and transitions during the training process.

Self-Efficacy

Self-efficacy describes an individual's judgment of his or her capability to achieve successful performance on a task. Persons with high levels of confidence for a

particular task readily and (more likely) successfully perform the task, whereas those low in self-efficacy avoid or abandon the task [63,64].

This study included a self-efficacy questionnaire which asked the participant to rate his or her level of confidence to perform the intubation procedure.

Psychological Stress, Arousal in Learning

Emotion is known to play a role in performance [65] and learning, and has been described in several models including Bloom's taxonomy of learning [66, 67]. Nixon's Stress Performance curve, [68, 69] and by Sincero [70]. This study also explored the use of skin impedance measures [71] as an indicator [72, 73] of trainee stress level during training and performance assessment [74, 75]

This study explored the use of Electrodermal Activity (EDA) measure [76, 77, 78] as an indicator of trainee stress level during training and performance assessment [79, 80]. EDA has been shown to reflect activity within the autonomic nervous system (ANS) in response to a stimulus. EDA measures provide a sensitive and accurate indicator of arousal. Changes in electrical properties of the skin produced by various emotional stimuli were first reported by Féré in 1888 [81]. Researchers representing a broad spectrum of applications recognize that EDA changes indicate the level of arousal during an emotional episode [82, 83, 84] Interest in the use of EDA continues to grow and has most recently been accelerated by its use to understand emotional response in computer based video games [85,86]. This study builds on the combined understanding of

learning and emotion and extended the use of EDA measures to assess the level of arousal experienced by training participants who were assigned to either live tissue training or simulation-based training. It is anticipated that the optimal level of arousal and engagement in the training process can facilitate peak performance and maximal learning, also known as “flow” [87] described by Csíkszentmihályi (1975), or “sweet spot” [88], described by Byrne (2010) [89]. The most effective training programs combine the optimal level of stress or arousal, and training skills, operating in the range of the “sweet –spot” located at the tip of the stress-performance curve [90].

Analysis of EDA measures presents some challenges and limitations. For example, analysis of the signal must account for inter-individual variability in addition to differences in activation between individuals.

The correlation of changes in the EDA measure must be matched with the onset of training with initial exposure to the training stimulus. Further refinement of analytic approaches is needed to characterize the differences in arousal associated with the live tissue training or the simulation training stimulus.

Technology standards and application development of EDA measures are rapidly evolving as an important method of assessing level of engagement in immersion experiences in computer based games [91].Combined cognitive science, learning theory and established physiologic recording technology provide the necessary theoretical underpinnings for use in this study.

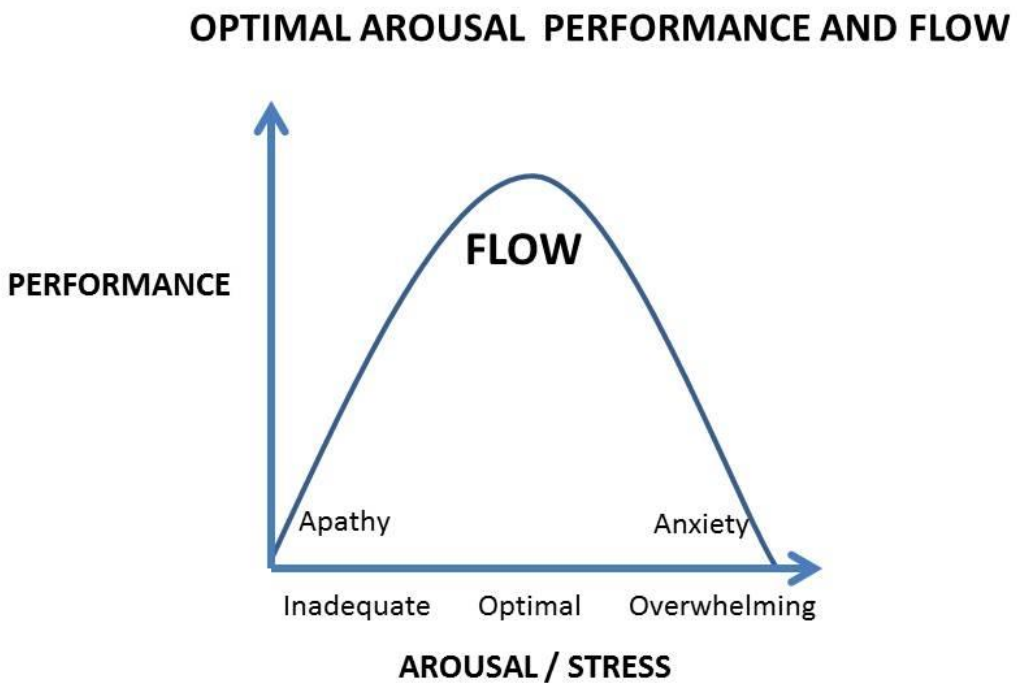


Figure 3 – Arousal and Performance Curve Relationship (adapted from Csikszentmihalyi, and Byrne)

Impact of Simulation-based Training on Patient Safety

Simulation based medical education is gaining wide spread appeal as a means to increase and expand medical skill training opportunities and enhance patient safety in a changing medical environment. It can be expected that advances in military trauma training will be adopted in civilian pre-hospital and medical practice. For example, similar training programs have been used in low-resource civilian settings [92] such as Cambodia and Vietnam where land mines have caused considerable civilian deaths and injury. Husum and colleagues report reduction in the death rate from 40% to 14.9% in Cambodia and North Iraq associated with a program which trained village members in lifesaving procedures [93, 94].

It is widely believed that simulation-based medical education is a key innovation for patient safety and medical skills education [95] SBT integrated into the educational and organizational improvement process enhances patient safety [96]. SBT has gained wide spread appeal with many simulation-based training programs being established in medical schools and teaching hospitals. In a recent survey, The American Association of Medical Colleges (AAMC) has shown that 86 of 90 participating medical schools in AAMC use simulation content in the courses at the preclinical level. An academic society dedicated to the study of the use of simulation in education and a peer-reviewed journal, *Simulation in Health Care,* has been established. Federal funding agencies, including the Agency for Healthcare Research and Quality's (AHRQ) have provided more than five million dollars in supporting research to enhance patient

safety through simulation-based training. Research publications in simulation have steadily increased over recent years and by 2011 the body of literature had grown to more than 10,000 articles which described research and practice of simulation-based training for a wide variety of medical skills [97]. In the literature review which follows, 196 reports involving pediatric intubation and simulation-based training were identified.

While more than 10,000 papers on simulation-based medical education studies have been published [98], and numerous studies have been conducted, it has been suggested that there are few studies which demonstrate the effect on patient care. The objective of this review is to summarize the evidence of the role simulation-based medical education has played in improving clinical performance measures of endotracheal intubation.

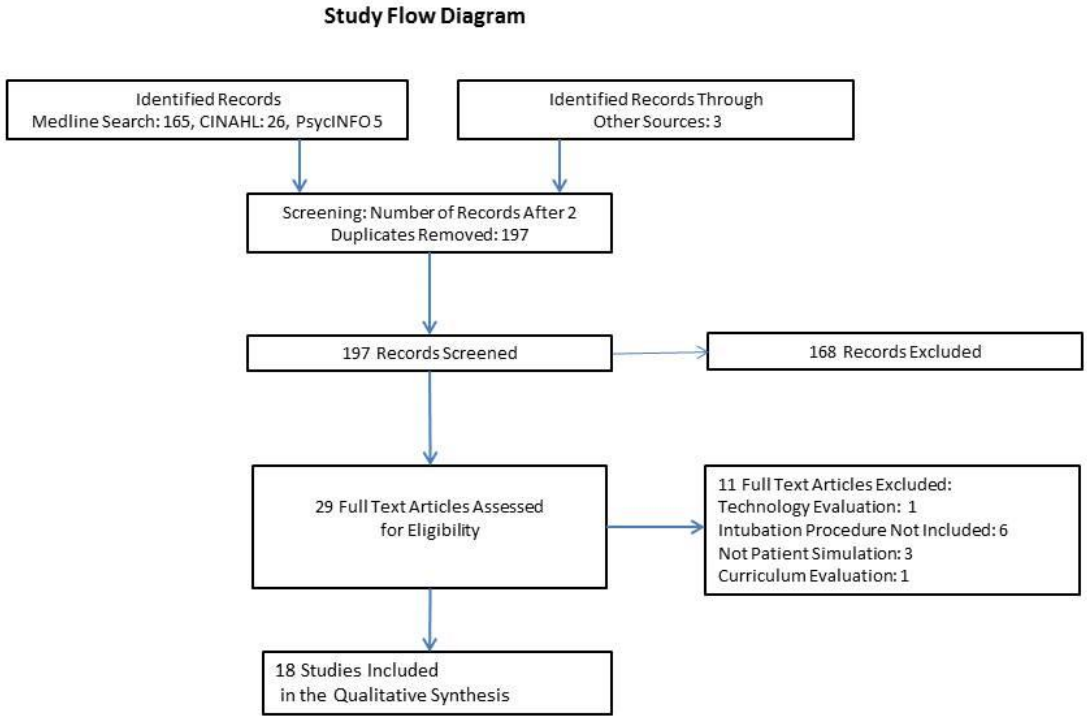
Methods: A structured systematic literature review was conducted using three well-regarded databases: Medline, PsycINFO and CINAHL. These data sources included published papers for the following time periods: MEDLINE, 1946 through January 2013; PsycINFO [from date] thru 2012; and CINAHL, 1982 thru January 2012. References in published articles were also reviewed. Articles included in the review were written in English, published in peer-reviewed literature, utilized simulation-based training as an educational intervention for endotracheal intubation, and included specified learning objectives. For each database search, the Medical subject heading (MeSH) terms “simulation” and “endotracheal intubation” were used. The MEDLINE search resulted in 165 citations. The CINAHL search resulted in 26 citations. The PsycINFO search

resulted in 5 citations. Several comprehensive systematic reviews have been published for simulation-based training including a meta- analysis conducted by Cook and colleagues, systemic reviews conducted by Issenberg [99], and McGaghie 2006 [100], a literature review of simulation and procedural skills [101], and airway management skills [102]. These reports were reviewed for additional articles. The references of the review papers were also reviewed to ensure complete coverage and this resulted in three additional articles. (See Figure 1)

Literature Search Results

The articles identified for review totaled 197 after two duplicate studies were removed. Of the 197 identified articles, 168 articles were excluded because the inclusion criteria were not met. Of the 29 remaining studies, the full text was appraised and an additional eleven articles were excluded for the following reasons: the primary objective of one study was to evaluate technology; six studies did not specifically measure intubation skill or knowledge; three studies did not involve patient simulation with a manikin; and one study was limited to curriculum evaluation. The published papers accepted for this study were carried out around the world, including such sites as: the US, Canada, Germany, Taiwan, and Israel. The characteristics of the included studies are summarized in Table 1.

Figure 4 - Literature Review Study Flow Diagram



These studies were summarized and compared using key features of the studies. The data extraction algorithm is modeled by principles described by Issenberg et al. [103]. The following fields of information were extracted, bibliographic information, study objectives, study design, study sample size, training level of participants, outcome measures, the number of days of training, and conclusions.

Evaluation of the Evidence of Effect of Simulation Based Medical Education (SBME) on Clinical Performance Measures for Pediatric Intubation

The studies were assigned impact factor based on the Kirkpatrick scale for educational interventions [104]. This scale assesses outcome on four levels, reaction to training, impact on learning, changes in behavior and organizational level outcomes. This model has been adopted for evaluation of simulation-based training in several notable studies including those by Salas et al. [105], and Cook [106], and McGaghie [107]. Because the focus of this study is related to the performance of a procedure, the Kirkpatrick Levels model has been adapted to include only those elements related to assessment of a procedure. The following descriptors have been used in the table below to describe the studies designs: Observational: Observational; 1GPP: One group, pre- and post- design; 2GPP: Two Groups pre- and post- design; RCT: Randomized Control Trial; RCTX: Randomized Control Trial, crossover. The main features of the reviewed studies, including the sample size, location of the study, clinical focus, study design and type of trainee are summarized in the table below.

Table 1: Characteristics of the Reviewed Studies

Study	Country	Clinical Area	Study Design	# of Learners	Learner Level
Pott et al., 2007 [25]	US	Anesthesiology	1GPP	28	Residents
Abrahamson et al.,	US	Anesthesiology	RCT	15	Residents

2004 [18]					
Barsuk et al., 2005 [19]	Israel	Surgery; anesthesiology	RCT	72	Residents
Batchelder et al., 2009 [20]	UK	Anesthesiology	1GPP	12	6 Practicing Physicians; 6 paramedics
Binstadt et al., 2008 [28]	US	Emergency Medicine	1GPP	21	Residents
Chen et al., 2009 [31]	Taiwan	Anesthesiology, Medical Education	Observational	266	Residents
Crabtree et al., 2008 [21]	Canada	Anesthesiology	RCT	30	Respiratory Therapists
Goldmann et al., 2006 [22]	Germany	Anesthesiology	1GPP	38	15 Residents; 23 Practicing Anesthesiologists
Johnson et al., 2008 [23]	US	Anesthesiology	RCT	22	Residents
Kovacs et al. 2000 [29]	Can	Emergency Medicine	RCT	82	66 Medical students; 16 Dentistry Students

Olympio et al., 2003 [24]	US	Anesthesiology	2GPP	21	Residents
Rowe, et al. 2002 [26]	US	Anesthesiology	2GPP	20	Residents
Russo et al., 2007 [27]	Germany	Anesthesia	Observational	88	62 Anesthesiologists; 10 Paramedics; 6 Anesthesia Nurses; 5 Internists; 4 Surgeons, 1 Pediatrician
Sudikoff et al., 2009 [30]	US	Critical Care Medicine	RCTX	16	Residents
Davis et al. 2007 [15]	US	Emergency Medicine	1GPP	120	Flight Nurses; Paramedics; not further specified
Hall et al., 2005 [14]	Can	Emergency Medicine	RCT	36	Paramedics
Mayo et al., 2011 [17]	US	Critical Care Medicine	Observational	9	Critical Care Fellows
Nishisaki et al.; 2010 [16]	US	Critical Care Medicine	1GPP	78	Residents

Study Designs: 1GPP: One group, pre- and post- design; 2GPP: Two Groups pre- and post- design; RCT: Randomized Control Trial; RCTX: Randomized Control Trial, crossover.

Results of Kirkpatrick Level Assignments

Two of the studies named above were completed in the pre-hospital setting [108, 109] and two of the studies were conducted in the hospital setting [110, 111]. The most frequent outcome assessment measure is change in behavior, Kirkpatrick level 3, utilized in 16 of the 18 studies. Ten of these studies are published in the anesthesia literature and include articles by Abrahamson [112], Barsuk [113], Batchelder [114], Crabtree [115], Goldmann [116], Johnson [117], Olympio [118], Pott [119], Rowe [120], and Russo [121]. Three of these studies were published in emergency medicine literature, including studies by Binstadt [122], Kovacs [123], and Sudikoff [124]. One study was published in the Emergency medicine literature, by Chen [125]. Three studies, including Batchelder [126], Pott [127], and Johnson [128], used knowledge assessment, Kirkpatrick level 2. Six studies assessed participant reaction to training Barsuk [129], Batchelder [130], Goldmann [131], Olympio [132], Russo [133], and Davis [134]. Six studies utilized surveys which addressed perceived value of the training, Kirkpatrick, Level 1. In nearly all the studies, participants demonstrated improvement in the procedural skill. Only the study by Batchelder (2009) used all three assessment approaches [135].

The results of this in-depth review indicated the need for development and increased use of a comprehensive approach for performance assessment. Nearly all of these studies described some level of improvement in skill associated with use of a simulator to train pediatric intubation. For this reason, it was hypothesized that simulation-based training would be associated with larger improvement in group learning outcomes. Also, because learning is associated with engagement of the student, it was hypothesized that the electrodermal activity measure would show larger increases with simulation-based training compared to live tissue training. Translational outcome measures for the reviewed studies are summarized in the following table.

Table 2: Summary of Translational Outcome Measures for Reviewed Studies

Study	Kirkpatrick Level Measured Outcome			
	Reaction	Knowledge	Behavior	Organizational
Abrahamson et al., 2004			Yes	
Barsuk et al., 2005	Yes		Yes	
Batchelder et al., 2009	Yes	Yes	Yes	
Binstadt et al., 2008			Yes	
Chen et al., 2009			Yes	
Crabtree et al., 2008			Yes	
Goldmann et al., 2006	Yes		Yes	
Johnson et al., 2008		Yes	Yes	
Kovacs et al. 2000			Yes	
Olympio et al., 2003	Yes		Yes	
Pott et al., 2007		Yes	Yes	
Rowe, et al. 2002			Yes	
Russo et al., 2007	Yes		Yes	
Sudikoff et al., 2009			Yes	
Davis et al. 2007	Yes		Yes	Yes

Hall et al., 2005			Yes	Yes
Mayo et al., 2011				Yes
Nishisaki et al.; 2010				Yes

3.0 METHOD

Overview

This study was approved by the University of Missouri Institutional Review Board and the Department of Defense Office of Human Subjects Protection. Because live anesthetized animals are involved, this study has also been reviewed and approved by the University of Missouri Animal Care and Use Committee (MU-ACUC) and Department of Defense Animal Care and Use Review Office.

Written consent was obtained from each participant. Class registration included collection of demographic information including age and years of experience and occupation. The stages of the study in order of completion were as follows: The first self-efficacy survey was completed. The participants completed a pre-training psychomotor assessment, pre-training skill assessment and a second self-efficacy survey. The training session consisted of a standardized, training session consisting of a narrated PowerPoint didactic presentation and followed by a hands-on equipment familiarization activity. Each training day included the SBT and the LTT arm. The participants were randomized into one of the two training arms and completed either the simulator-based training or live tissue training session. Following completion of the training, psychomotor and knowledge assessment instruments were completed as well as a third self-efficacy survey and course evaluation. A brief semi-structured interview was conducted with some participants as selected by study staff. The entire training event required 3-4 hours to complete.

Leadership and Organization

The Combat Casualty Training Consortium (CCTC) was established to conduct a direct comparison of SBT and LTT and work to accelerate research and development of SBT using an established technology development approach [136]. The CCTC includes representatives from academic, industry, government stakeholders and recognized experts, who provided oversight to the research. It includes three academic centers, two Department of Defense (DOD) animate training sites, and a certified veterinary research facility. The University of Missouri led the project, coordinated interagency efforts, and conducted the training study for management of cholinergic crisis and neonatal and pediatric intubation. An appointed Board guided and monitored the research effort. A separate academic institution, the University Of Central Florida Institute Of Simulation and Training (UCF- IST) independently conducted an interim assessment of the study process and execution.

Facilities

A description of each of the partner agencies and centers follows.

The University of Missouri School of Medicine Sheldon Simulation Center is a state of the art medical educational facility with extensive experience utilizing full-body computerized patient simulators, standardized patients, virtual reality/computer simulations, task trainers and hybrid simulations.

The MU College of Veterinary Medicine (VMTH) is a state-of-the-art veterinary medicine facility. The VMTH is an approved facility by the Association for Assessment and Accreditation of Laboratory Animal Care (AAALACC) for teaching, research, and medical service.

Simulation-based Training Session

The simulation-based training sessions were conducted by a trained staff member with groups of five to seven participants. The simulator used was the PediaSIM partial task trainer. Each participant was given the opportunity to practice the intubation procedure.

Live Tissue Based Training Sessions

The live tissue-based training sessions were conducted with the supervision of a veterinarian with groups of five to seven participants. Attendees were instructed to don personal safety equipment and approach the live anesthetized ferret. Each participant was given the opportunity to do the intubation procedure.

Data Collection

Data collection was accomplished by members of the training team who were not involved in teaching either the SBT or the LTT sections. Following completion of the informed consent, participants created a unique coded identifier. Next each participant put the Q-sensor wrist-band on his or her non-dominant hand. The test measurement instruments were contained within a secure Computer based Assessment System (CAS) or Xoom device. The CAS was used for data collection of the demographic surveys, the self-efficacy questionnaires, the

knowledge assessments, the psychomotor skills' assessments, the Affectiva Q Sensor data, and the data from the post-training course evaluation survey.

All data were compiled on a single, secure server and securely exported by site management for aggregate analysis.

Sampling Design and Selection

The target study population included men and women adult active duty, guard and reserve military participants who were experienced at their respective levels in acute care and who were scheduled for later participation in annual military combat medical training through US Air Force Center for Trauma and Readiness Sustainment (USAF CSTARS) in St Louis. Only one fifth of the CSTARS students are expected to ever be in a position or job assignment that would require them to intubate a child. Therefore, only those individuals with practical application for pediatric intubation had the need for specialized training, and were offered the opportunity to receive the training and participate in the study. The potential participant pool included 80 United States Air Force (USAF) personnel who were anticipated to later take training at CSTARS. To increase the sample size, a civilian component with need for pediatric airway training was also included. Civilian staff members, medical students, and paramedical personnel working or training at the University of Missouri with a prescribed need for pediatric airway training were also included in the target sample. The goal sample size was 20 students per event (mix of military and civilian) and 80

participants were included in this analysis. Some participants had not received prior military or civilian training in pediatric and neonatal intubation procedures. The military medics were attached to a nearby military facility and were required to take the training; while the civilian participants included those who either trained or worked locally. Thus, the sample was one of convenience.

Generalizability, Study Power, and Expected Attrition Considerations

All study participants were experienced at their respective levels in acute care with a minimum of basic life support training experience. The estimated attrition rate was less than 10%. It was anticipated that results of the study may be generalized to the population of deployed combat medics, a group roughly estimated at 2000 individuals. Despite the “convenience” aspect of this sample, its homogeneity of experience and relevant population characteristics supported confidence in the sample statistics to reliably mimic population parameters for generalization.

Methods to Account for Different Levels of Training and Experience Among Participants

At the time of training, demographic information was collected from the study participants, including: gender, prior and related medical training, and military rank. Specific demographics were selected because each contributed to a better understanding of the research questions. A three-stage sampling plan, quasi-experimental design was deployed. The stages are summarized as follows: the

overall population included eligible combat medics in the armed forces. This is a defined and finite group; however not everyone in the group was available for selection. In fact, only a few of the overall population were available for the study. Individuals from the overall population who were geographically proximal to the study sites and in a unit were recruited to participate in the study. This convenience sample was the first stage of the sampling plan. This is advantageous for building the sample because it precluded participants from being self-selected, as it has been well accepted that self-selection typically results in a biased sample. In the second stage, stratified cohort groups were identified using demographic information collected from each individual. This was accomplished using the following assignment rules:

1. Military or Civilian status
2. Occupation (within each group)
3. History of previous live tissue training
4. History of previous simulation training
5. Gender

Using these demographic criteria, individuals were placed into one of three cohorts. This process stage was stratified to ensure equal representation of relevant demographic criteria in each cohort. Once an individual was assigned to a “cohort” he or she could not move to a different group. Finally, each individual was randomly assigned to one of the training conditions. The random assignment to a treatment helped minimize sampling bias in the previously designated cohort

groups. Once the cohorts were established, the training treatment assignments were distributed.

Inclusion / Exclusion Criteria

The inclusion criteria for participant recruitment included the following criteria: minimum prior medical exposure of at least Combat Life Saver or Basic Life Support designation or higher; and a need for the training. The USAF medic's participants were completing a requirement for annual medical sustainment training through the USAF Center for Sustainment of Trauma and Readiness Skills (CSTARS) St Louis.

Exclusion criteria for this study include the following criteria: Participants who were less than 18 years of age and prisoners. The informed consent process was provided in the English language and non-English speaking individuals were excluded for this reason. Those individuals who did not desire to have their performance recorded as a part of the research study were excluded from data collection, but were allowed to complete the training.

The immunization requirements for live animal interaction are the same as those for the practice of medicine. All CSTARS St Louis participants were required to have up-to-date immunizations prior to selection to attend the annual training at CSTARS.

Participant Recruitment & Screening

The Air Force Expeditionary Medical Skills institute agreed to support this effort through incorporation of combat medics as part of their standard sustainment

training program, allowing these medics to qualify for participation in this study. All CSTARS students from the St Louis CSTAR program participated in this training event as part of their required annual medical skills sustainment training program. (See attached Letter of Command Support, Appendix L). CSTARS students were not required to participate in the study and provided signed informed consent to be evaluated.

Informed Consent Process, Privacy, and Decision to Participate

The principal investigator or a trained study representative invited participants to participate in the study following the Course and Research Study Introduction (see Research study diagram) as the first activity in the training program, prior to all testing and data gathering. It was made clear by the PI and/or the trained study representative that all CSTARS participants partake in the training and that the confidential data collection (i.e. participation in the research project) has the support of their Commander (See Appendix). Neither the USAF CSTARS Cadre nor the USAF School of Aerospace Medicine staff had knowledge of which training participants also consented to participate in the research study and which did not provide consent. No MU training program directors or paramedical support managers had knowledge as to which training participants consented to participate in the research study and which did not provide consent.

Study Procedure

The research study process entailed the following steps (see Figure below)

Informed Consent Presentation and Completion of the Consent Forms

The principal investigator or a trained study representative discussed the Informed Consent Process, completion of the consent form, protection of information, and reasons for the study. All participant questions were answered. Participants returned the Statement of Consent form prior to the start of training and data collection. This approach allowed time for each participant to privately consider the opportunity and independently decide whether or not to participate in the study. The PI or a trained study representative was available at all times to answer participant questions.

Introduction to Course and Distribution of Equipment

The principal investigator or trained study representative introduced the training staff and the training schedule for all participants. Each participant received a Xoom tablet (computerized assessment system). Each student also received an Affectiva Q Sensor wrist device which measures skin impedance, providing an estimation of the sweat on the skin.

Registration & Demographic Survey

Each participant individually, completed the same registration and demographics questionnaire on his or her assigned Xoom collection device.

Pre-training Assessment:

Baseline Skin Conductance and Temperature Measures

The Q Sensor was placed on the participant's wrist. He or she wore the Q Sensor throughout the entire study. Baseline skin impedance was recorded and

the skin-impedance was continuously recorded throughout the training segment of the study.

Self-efficacy Survey #1

Each participant individually completed an initial self-efficacy questionnaire to measure his or her level of confidence in the performance of the procedure on their assigned Xoom collection device.

Pre-Training Knowledge Assessment

Each participant individually completed a baseline multiple-choice knowledge assessment that measured their pre-training knowledge of the procedure on their assigned Xoom collection device.

Pre-Training Skill Assessment

Each participant had a pre-training performance evaluation on the procedure utilizing a high fidelity human patient simulator. This was scored by the observer on the student's assigned Xoom collection device.

Self-efficacy Survey #2

Each study participant took a second self-efficacy questionnaire following completion of their pre-training skills assessment to measure any changes in his or her level of confidence in the performance of the procedure following the first skill assessment.

Training

Standardized Didactic Presentation

All participants received a standardized didactic power point presentation on the procedure.

Training Groups

High Fidelity Human Patient Simulator

The training group utilizing high fidelity human patient simulators was trained in a combined laboratory classroom with an expert instructor for hands-on training in the procedure; and that training protocol followed a standardized training curriculum.

Animal Tissue Model

The Live Tissue Training group was transported to the College of Veterinary Medicine and. Following a safety briefing and issuance of personal protective equipment, the participants underwent standardized hands-on training with an expert instructor who utilized a standardized training curriculum protocol.

Post Training Assessment

Knowledge Assessment

Each participant individually completed a post-training multiple-choice knowledge assessment that measured knowledge of the procedure. This assessment was conducted on his or her assigned Xoom collection device.

Post Training Skill Assessment

The expert observer evaluated the participants' post training performance of the procedure utilizing a high fidelity human patient simulator. The scored observation was done on the participants' assigned Xoom collection device.

Self-efficacy Survey #3

Each study participant took a third self-efficacy questionnaire following completion of their post training skills assessment to measure any changes in his or her level of confidence in the performance of pediatric intubation following their training**.**

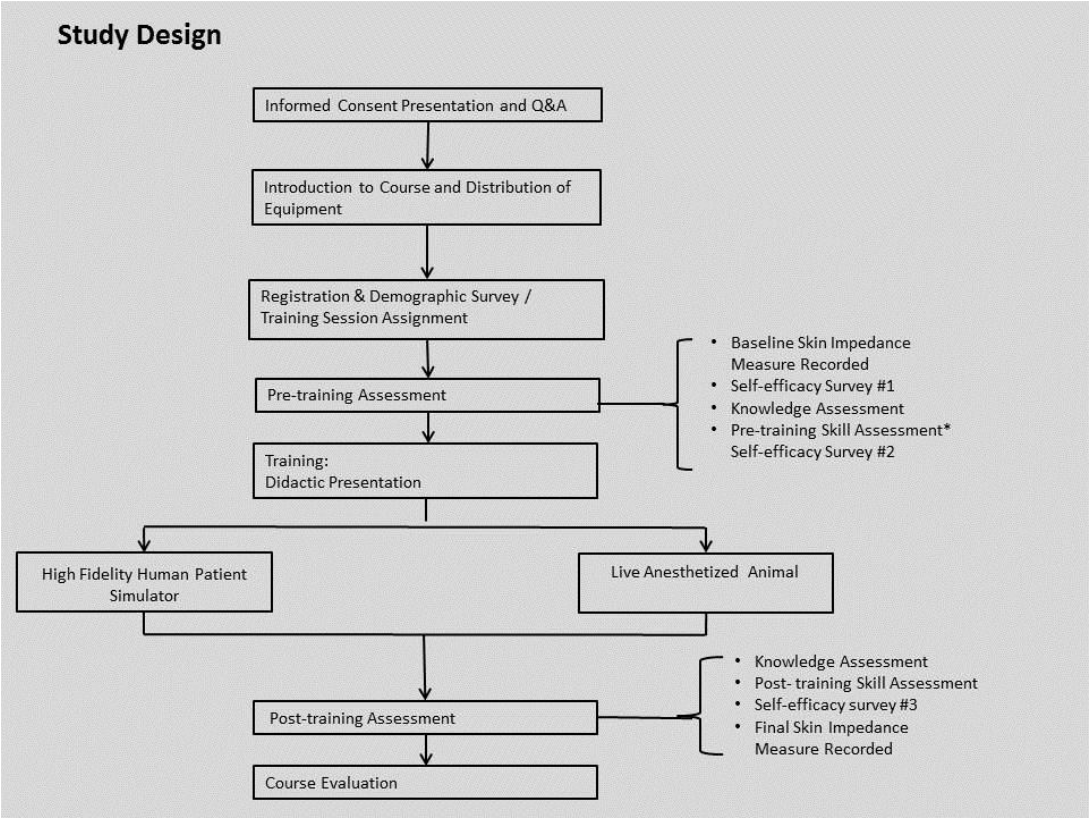
Affectiva Q Sensor Data

The de-identified and secure skin impedance data was downloaded and linked to the individual student performance and training data.

Course Evaluation

Each participant individually completed a brief evaluation of the training. A limited number of randomly chosen students were interviewed to elicit their verbal evaluation of their training experience to provide greater depth of understanding, and to offer a cross-check to the self-reported survey data. The following flow diagram shows the research study design including training and performance assessment activities.

Figure 5 – Study Design



Statistical Analysis

The statistical analyses investigated possible relationships between the dependent and independent variables. The independent variable was assigned training group; with the levels of either LTT or SBT. The dependent variables included: the Knowledge Assessment Score, Psychomotor Score, Self-efficacy score, Skin impedance Measure, and Perceived Value of the training experience.

Hypothesis # 1: There is a significant difference between groups in changes in knowledge scores. The data type is interval, discrete. The end point measure is change in knowledge assessment score (number of items correct) indicated in the pre- and post-training knowledge assessment. Hypothesis #2: There is a significant difference between groups in changes in psychomotor scores. The endpoint measure is change in psychomotor assessment score indicated in the pre- and post-training assessment. The data type is interval, discrete. Hypothesis #3: There is a significant difference between groups in the changes in self-efficacy scores. The end point measure is the change in self- efficacy summated score indicated in the pre-post training survey. The data type is ordinal, discrete. Hypothesis #4: There is a significant difference between groups in changes in skin impedance scores. The end point measure is change in skin impedance measure from baseline compared to post assessment measure. The data type is ordinal, discrete. Hypothesis #5: There is a significant difference between the LTT and SBT groups in the perceived value of the training. The data type is ordinal, discrete. In addition to descriptive statistics, ANOVA with two

conditions was conducted. Data were entered into an Excel spreadsheet and analyzed using SAS 9.2 (Cary, North Carolina).

Hypothesis

1. H_0: There will be no difference in the change in cognitive assessment scores between the simulation-based training and the live tissue based training.

   H_1: The simulation-based training will have greater improvement in the cognitive test scores than the live tissue based training.

2. H_0: There will be no difference in the change in psychomotor test scores between the simulation-based training and the live tissue based training.

   H_1: The simulation-based training will have greater improvement in psychomotor test scores than the live tissue based training.

3. H_0: There will be no difference in changes in trainee confidence as indicated in the self-efficacy surveys, between the simulation-based training compared to the live tissue based training.

   H_1: There will be a larger increase in trainee confidence as indicated in the self-efficacy surveys, between the simulation-based training compared to the live tissue based training.

4. H_0: There will be no difference between trainee's skin-impedance, in the simulation-based training compared to the live tissue based training.

   H_1: There will be a difference in trainee measured skin impedance, in the simulation-based training compared to the live tissue based training.

5. H_0: There will be no difference between trainee's perceived value of the course, as indicated in the course evaluation survey between the simulation-based training and the live tissue based training.

   H_1: There will be a difference between trainee's perceived value of the course, as indicated in the course evaluation survey between the simulation-based training and the live tissue based training. Need to add a sentence to introduce the table below.

Table 3 - Statistical Analysis Summary

Hypothesis	Specific Aim	Dependent Variable/Endpoint Measure and Data Source/Instrument	Data Type / Analysis
There will be statistically significant differences in changes in knowledge, psychomotor performance, self-efficacy, and affect between participants trained utilizing simulation (SBT) or live tissue animal models (LTT).	1. a. To determine if there is a significant difference between groups in changes in knowledge scores.	Change in Knowledge (Multiple Choice) Assessment Score (number of items correct) indicated in the pre and post training assessment.	ANOVA with 2 conditions with four dependent variables Data type: Interval, discrete
	1. b. To determine if there is a significant difference between groups in changes in psychomotor scores.	Change in Psychomotor Assessment Score indicated in the pre and post training assessment.	ANOVA with 2 conditions Data type: Ordinal, discrete
	1. c. To determine if there is a significant difference in self-efficacy summated score indicated in the pre-post training survey.	Change in in self-efficacy score indicated in the pre and post training survey.	ANOVA with 2 conditions Data type: Ordinal, discrete self-efficacy scores

	1. d To determine if there is a significant difference between groups in changes in skin impedance scores.	Change in skin impedance measure from baseline compared to post assessment measure	ANOVA with 2 conditions Data type: Ordinal, discrete
There will be statistically significant differences between the LTT and SBT groups in perceived value of the training.	To determine if there is a significant difference between the LTT and SBT groups in perceived value of the training.	Summated score Course Evaluation Survey	Same as above Data type: Ordinal, discrete

Survey and Assessment Instrument Development and Validation

The validity and reliability of the performance assessment measures were important to the quality and success of this project. They were important for two reasons: the assessment instruments in this project provided information in the comparative effectiveness of the training modalities; and these instruments were expected to serve as a basis for further development as training methodology linked to evidence of clinical proficiency. Many perspectives of validity have evolved over time [137,138], and have been addressed here. Test validity, related to the use of the test, is "the degree to which evidence and theory support the interpretations of test scores [139,140] and has been confirmed through subject matter expert review, and review of the literature [141,142].

The content validity has been established for the instruments in this project. For the psychomotor checklist, the procedure construct was carefully defined as a series of steps based on information in the intubation literature and by consulting subject matter experts. Each procedural step is further defined as to how it is accomplished and the criteria to judge accomplishment. Criteria were established through consensus. Careful attention was essential in this process to demonstrate that the measurement tool mapped appropriately to the construct. This approach was essential in establishing the “trustworthiness” of the psychomotor assessment. The psychomotor checklist was developed and reviewed by consulting with subject matter expert members of the consortium and by reviewing methods in the literature [143,144]. The test-retest reliability of the psychomotor pre- and post-tests was evaluated with Cronbach’s alpha statistic and was high (alpha = .948) [145].

The knowledge assessment validity was established through subject matter expert review and consensus on questions. The knowledge assessment was then administered on two separate occasions without intervention to a group of students. The Coefficient of Stability for Instruments is a measure of the correlational relationship between two administrations of the same test and is .621 for the knowledge assessment (Personal communication, Steve Osterlind, Consulting Statistician). It is anticipated that these numbers will improve with larger sample size; .7 is the minimum acceptable threshold. With no intervention

between test administrations, it is a proxy for reliability. With intervention, however, it is anticipated to be low, reflecting the effect of the intervention.

The Self-efficacy Survey was developed by subject matter expert members in the MU CCTC. The test-retest reliability is acceptable. Cronbach's alpha statistic is .979 [146].

Observer Rater Anchoring Process and Inter-rater Reliability

The scoring reliability of the psychomotor checklist was confirmed by conducting what has been called an "anchoring session" to ensure inter-rater reliability. This was accomplished by training all observers in the use of the psychomotor checklist and grading the trial assessments. In this automated process, the observers logged into the checklist list application. In the classroom setting, several trials mimicking student actions were described while observers who were being trained "graded the mock intubation" using the psychomotor checklist. The mock trials were conducted with planned mistakes in performance of the intubation procedure. The results of each grader were compared with the lead or master assessment. In this way, initial concordance was reviewed. The second part of anchoring the observers was conducted in the simulation lab with a "mock student" performing the intubation with planned mistakes. Again, the observer grading results were compared with a "master" grade record. The concordance report was then reviewed by all participants to understand which steps in the intubation procedure were associated with grading mistakes and which observers

needed additional training. Additional trials were conducted in the classroom and simulation lab until a high degree of concordance was achieved to establish: agreement between the observer controllers. In 15 designated trials in the classroom and simulation lab, six observers were graded with intra-rater reliability measures of 94%, 94%, 96%, 94%, 95%, and 95%.

Controls/Risks

The study has been approved by the University of Missouri Institution's Institutional Review Board (IRB) and Use of Animals Board (IACUC) along with overall approval of the entire study by the equivalent DOD agencies. After the test trials began, an interim independent review was completed by the University of Central Florida Institute for Simulation and Training. The independent evaluation team did not participate in the research, but reviewed each part of the study design. The instructor training was standardized. The training was conducted with observers/controllers on the performance-based checklists to ensure that they consistently and reliably evaluated the required procedures. The Computerized Assessment System (CAS) Test Administrator training was conducted at each site prior to conducting the study trials to ensure that all administrations are consistent. Affectiva Q Sensor training was conducted to ensure that all administrations were equivalent. Validation of instruments was completed on all instruments (knowledge assessment questions, self-efficacy questionnaires, performance checklists, the evaluation survey, and Affectiva Q

Sensor) in pilot tests prior to the test trials. A pilot test with the protocols of training and all of the testing instruments was conducted.

Research Project Evaluation

The internal and external procedures for data safety monitoring were in place. All aspects of the research study including design, conduct, and evaluation were overseen by the CCTC Board. An independent interim evaluation of the results and interpretation was conducted by the University of Central Florida.

Periodic assessment of data quality and timeliness was conducted beginning with review of the pilot test results with specific attention given to the training process and data collection, accuracy and completion. The participant recruitment and participation through training completion has been summarized and reported on a quarterly basis. The study results and preliminary data analysis was reviewed following the pilot tests and during each regularly scheduled quarterly board meeting. Course evaluation results, as well as formalized training session reports completed by the site instructors were also reviewed by the CCTC Board during quarterly meetings. This has provided ongoing assessment of participant risk and training benefits, research study performance, and identification of unanticipated factors which can impact study outcomes.

4.0 RESULTS

Demographics

The training sessions were conducted during from November 2012 through April 2013. One hundred percent of the participants agreed to participate in the research study. The classroom lecture portion of the training sessions was conducted in the University of Missouri Simulation Center. The live tissue training portion was conducted in a School of Medicine training procedures lab.

The analysis involved a total of 79 participants who were randomized into either the simulation-based training arm or the live tissue training arm. The total number of participants in the SBT group was 40 and the LTT group had 39 total participants. The average age of participants in the SBT group was 32.8 (S.D. 8.7) years. The average age of participants in the LTT group was 33.3 (S.D. 9.6). In the SBT group 21 were women and 19 were men. In the LTT group 16 were women and 23 were men. Experience among civilian personnel was defined as more than 4 years of experience. Among military personnel, experience was defined as more than 3 years. The SBT group had 13 experienced participants and the LTT group had 16 experienced participants. In the SBT 14 of 40 participants were military and in the LTT group, 16 of 39 participants were military. The participant demographics are summarized on Table 4, below. Student's t-test was performed for each demographic category and revealed non-significant differences in age, gender, experience and military or civilian status

between the SBT and the LTT groups. The probability values are summarized in the following table.

Table 4 - Demographics of Study Participants

Demographics	SBT	LTT	T-test probability value
Participants	40	39	
Age (years)	32.8 (S.D 8.7)	33.3 (S.D 9.6)	0.8555
Gender (women, n=37; men, n=42)	Women: 21 Men: 19	Women: 16 Men: 23	0.2734
Experience	Experience: 13 Non-experienced: 27	Experience: 16 Non-experienced: 23	0.1133
Military or civilian	Military: 14 Civilian: 26	Military: 16 Civilian: 23	0.7762

Distribution Analysis of Dependent Variables

The SBT groups' mean change in Knowledge Assessment score was 4.23 with a standard deviation of 2.69. The LTT groups mean change in Knowledge Assessment score was 3.50, with a standard deviation of 2.43. The distribution of changes in this score was a normal distribution curve for both the SBT and the LTT groups.

The SBT groups' mean change in Psychomotor Critical Skills score was 3.60, with a standard deviation of 3.50. The distribution of the SBT group score was a normal distribution. The LTT groups mean change in Psychomotor Critical Skills score was 2.87, with a standard deviation of 3.65. The distribution of the LTT group score was a non-normal distribution, due to long right tail.

The SBT groups' mean change in Psychomotor All Skills score was 11.11 out of 50 steps, with a standard deviation of 8.01. The distribution of the SBT group score was a normal distribution. The LTT groups' mean change in Psychomotor Critical Skills score was 9.48, with a standard deviation of 8.16. The distribution of the LTT group score was a normal distribution curve.

The SBT groups' mean change in Self-efficacy score was .28 on a 10 point scale, with a standard deviation of .32. The distribution of the SBT group score was a non-normal distribution. The LTT groups mean change in Self-efficacy score was .26, with a standard deviation of .30. The distribution of the LTT group score was also a non-normal distribution. Both sample distributions demonstrate

kurtosis with increased number of scores concentrated in the middle region with short tails.

The SBT groups mean change in EDA was 2.67µS (range of measurement 0.07 – 9.42 µS). The standard deviation was 2.27 µS. The distribution of the SBT group score was a normal distribution. The LTT group mean change in EDA was 2.62 µS (range .000112 – 4.87), with a standard deviation of 2.35 µS. The distribution of the LTT group score was a non-normal distribution with many sample values concentrated in the lower half of the distribution and no left tail.

The course evaluation included ten questions about various aspects of the training process including lecture and practice session components. This analysis includes the two questions which help characterize the participant's perceived value of the training that the study participant just completed, for either the SBT or LTT condition. Specifically, the response data set included the survey response, on a four-point Likert scale, from SBT participants asked to respond to "I learned the most about neonatal pediatric intubation from the hands on training experience with the patient simulator. The LTT participants were asked to indicate the level of agreement on a 4-point Likert scale, with the following question, "I learned the most about neonatal/pediatric intubation from the hands-on training experience with the live animal."

The SBT groups mean score on the Course Evaluation survey questions was 2.58, with a standard deviation of 0.81. The distribution of the SBT group score was a non-normal distribution. The LTT groups mean score on the Course

Evaluation survey question was 3.05, with a standard deviation of 0.94. The distribution of the LTT group score was a non-normal distribution.

Based on the results described above, the analysis of variance was a Kuiper Two-Sample Test**.** This test is a non-parametric test that allowed for analysis of data that did not have a normal distribution. The findings are summarized in Table 5, below.

Table 5 - Summary of Training Group Assessment and Survey Mean Scores and Distributions

	Mean	Standard Deviation	Test for Normality, Kolmogorov-Smirnov, Pr > D, p-value
Knowledge Assessment SBT Group	4.23	2.69	0.49
Knowledge Assessment LTT Group	3.50	2.43	0.15
Psychomotor Critical Skills SBT Group	3.60	3.50	0.12
Psychomotor Critical Skills LTT Group	2.87	3.65	0.01
Psychomotor All Skills SBT Group	11.11	8.01	0.15
Psychomotor All Skills LTT Group	9.48	8.16	0.15
SE change score SBT Group	0.28	0.32	0.01
SE change score LTT Group	0.26	0.30	0.01
EDA SBT Group	2.67	2.27	0.08
EDA LTT	2.62	2.35	0.01
Course Evaluation SBT	2.58	0.81	.01
Course Evaluation LTT	3.05	0.94	.01

In the use of analysis of variance (ANOVA), the assumption was that all groups were simply random samples of the same population. This assumption implies that all treatments have the same effect (perhaps none), or there is no difference between the treatments. Rejecting the null hypothesis implies that different treatments result in altered effects. Non-parametric analysis of variance was conducted for each dependent variable and the results are summarized in the table below as well as described in the following sections. For all tests, non-significant differences were obtained.

Table 6 - Analysis of Variance Group Means, Change in Score

Analysis of Variance Group Means, Change in Score	Kuiper Two-Sample Test (Asymptotic)	p-value
Knowledge Assessment (Mean change score: SBT = 4.23; LTT =3.50)	Pr > Ka	0.9454
Psychomotor Critical Skills test score change (Mean change score: SBT = 3.6; LTT =2.87)	Pr > Ka	0.9239
Psychomotor All Skills test score change (Mean change score: SBT = 11.11; LTT =9.48)	Pr > Ka	0.9846
Self-Efficacy Questions: intubation of a simulator (Mean change score: .28; 10 point scale)	Pr > Ka	1
Self-Efficacy Questions: intubation of a live animal (Mean change score: .26; 10 point scale)	Pr > Ka	0.1072
EDA Mean Difference Baseline compared to training period (Mean change score: SBT = 2.67; LTT =2.62)	Pr > Ka	0.5788
Course Evaluation (Mean change score: SBT = 2.58; LTT =3.05)	Pr > Ka	0.3999

ANOVA Knowledge Assessment

The knowledge assessment test consisted of 20 multiple choice questions. A nonparametric ANOVA, Kuiper Two-Sample test was conducted. The resulting p-value was .9454. There was not a significant difference between the changes from pre to posttest administration between the two groups, live simulation-based training and live tissue training.

Table 7 - Analysis of Variance Group Means, Change in Score

Analysis of Variance Group Means	Kuiper Two-Sample Test(Asymptotic)	p-value
Knowledge Assessment	Pr > Ka	0.9454

ANOVA Psychomotor Assessment, All Skills and Critical Skills

Table 8 - Analysis of Variance Group Means, Psychomotor Assessment Change in Score

	Kuiper Two-Sample Test (Asymptotic)	p-value
Psychomotor Critical Skills test score change	Pr > Ka	0.9239
Psychomotor All Skills test score change	Pr > Ka	0.9846

The psychomotor test consists of 50 steps which include critical and non-critical steps for the intubation procedure. The steps include equipment set up and checking, patient preparation the intubation procedure with correct technique, confirmation of correct placement, and securing the endotracheal tube. Each participant is graded on performance of the steps in the checklist by a trained observer who marked each step as accomplished or not accomplished. A nonparametric ANOVA, Kuiper Two-Sample test was conducted. The resulting p-value is .9239. No significant difference was detected in the performance between the simulation-based training group and the live tissue trained training group in the intubation procedure.

The psychomotor, critical skills test consisted of the following subset of steps, assemble equipment, position/prepare the patient, visually identify the epiglottis

and vocal cords, intubation, cuff inflation and securing the endotracheal tube. Each participant was graded on performance of the steps in the checklist by a trained observer who marked each step as accomplished or not accomplished. A nonparametric ANOVA, Kuiper Two-Sample test was conducted. The resulting p-value was .9846. No significant difference was detected in the performance between the simulation-based training group and the live tissue trained training group.

ANOVA Self-Efficacy Survey

The participants completed a self-efficacy survey three times. All three versions of the survey were identical. Survey 1 was completed at the beginning of the training session before the pre-test skills demonstration. Survey 2 was completed after the study participant completed the pre-test skills demonstration, but before training. Survey 3 was completed after the skills post-test. The change in confidence from Survey 2 to Survey 3 was used. Survey 2 was chosen for the comparison because it is believed that this confidence estimate best represents the participants informed self-assessment.

The survey included fourteen questions which asked about different procedures and different training modalities, such as lecture or simulation-based training. This analysis includes two questions. The study participant is asked to indicate his or her degree of confidence, on a scale 0 -100% in performing:

1. Neonatal /pediatric intubation on a patient simulator; or,

2. Neonatal/pediatric intubation on a live animal.

For the question regarding “a simulator”, there is no significant difference in the survey question response between the groups trained with live anesthetized ferret compared to the group trained with the simulator (p-value = 1.0).

For the survey question, “intubating a live animal”, There was no significant difference in the survey question response between the groups trained with live anesthetized ferret compared to the group trained with the simulator (p-value = .1072).

ANOVA Electrodermal Activity Measure

The research study participants were asked to wear the Q-Sensor wrist band which measures skin impedance from the beginning of the training event. Time markers were noted for each class including the end of the baseline period, which was designated as the end of the PowerPoint presentation. The beginning of hands on training with either the SBT or the LTT was also noted. The participants removed the device after the hands on training segment with either the simulation or the live tissue training.

The mean change from the baseline period compared to the training period was calculated for each study participant; ANOVA of the mean difference of the EDA measure for the simulation-based training group compared to the live tissue training group showed no significant difference between the group that trained with live tissue compared to the group that trained with simulation (p-value = .5788).

Course Evaluation ANOVA and Survey Results

The course evaluation survey asked ten questions related to various aspects of the training process such as lecture and the hands-on training sections. Two of the 10 questions are included in this analysis. The participants who trained with the simulator were asked to rate his or her level of agreement with the following statement. “I learned the most about neonatal/pediatric intubation from the

hands-on training experience with the patient simulator." The study participants who trained with the live anesthetized ferret were asked to rate his or her level of agreement with the following statement. "I learned the most about neonatal/pediatric intubation from the hands-on training experience with the live animal." The participants were asked to rate his or her level of agreement using a Likert scale (1-4) with the number 4 being strong agreement. A nonparametric ANOVA was conducted using a Kuiper Two-Sample Test which yielded a non-significant result (p-value=0.3999).

Summary of Interview Comments

Sixty-one of the 80 participants participated in semi-structured interview at the end of the training day. All interviews were conducted by the same person. Interviews ranged from 3 minutes to 5 minutes with most interviews taking about five minutes. Most interviews were conducted with one participant at a time. At least three interviews included more than two people concurrently due to time constraints. The following questions were asked:

1. What kind of work do you do?
2. What kind of training did you do today?
3. How did the training go?
4. Is there anything else, positive or negative which you think we should know about it regarding this training?

Overall there were twice as many positive comments about live tissue training than simulation-based training(45 compared to 20) and there were twice as many negative comments about simulation-based training compared to live tissue training (6 compared to 3). Five of the 60 interviewees described appreciation of both modalities.

Table 9 - Course Evaluation Summary of SBT or LTT Related Comments

Ferret: Has a floppy tongue, secretions, real tissue, (had to be) more careful Emotions with living creature, body movement, and wont' see that on a manikin Gag, actual secretions – forgot suction in testing Knowing the feel of live tissue is essential, e.g. "pop, of the needle" in LTT LTT see vocal cords open/close see chest rise Cutting into the live issue, spasms, bleeding
Manikin: Mannequins are very stiff –(monitoring--hearing, listening… no breath sounds Ok for skill sustainment Good for deliberate practice Good for first experience Muscle memory practice with a simulator

5.0 DISCUSSION

Overview of Findings

The ANOVA results did not identify a statistically significant difference between the two groups, SBT and LTT, in knowledge, skill, or self-efficacy outcomes. These results indicate that for most learners the training modality may not be a significant factor in learning outcomes. It is also possible that there is a difference between the two groups, SBT and LTT that was not detected due to small sample size. Variables that were not included in this study may be obscuring the differences between the training groups. For example training level or years of job experience may be a factor in learning outcomes. This may be explored in future work.

The use of the electrodermal activity measure seems feasible and provided usable data. The statistical results of this research project did not detect a difference between the two training groups. The wrist device was reliable in recording and transmitting the measures data. The accompanying software provides a data file which is exportable to a spreadsheet and most statistical analysis packages.

Much insight has been gained for next steps to better understand the impact on learning outcomes of these two training modalities. The knowledge assessment may be further developed by reducing the complexity of the question structure. Some questions may be eliminated due to ambiguity. The psychomotor checklist seems to be an especially strong component of the performance assessment.

Consistency in using this checklist is essential, requiring a substantial anchoring process to ensure this. The self-efficacy survey could be fine-tuned to probe the participant about his or her confidence in performing specific elements of the procedure which are essential to successful performance, or about confidence in performing the procedure on a human patient. This could also help target instruction and practice.

As mentioned there may be a difference in impact on learning outcomes and it may be possible to demonstrate an impact on learning outcomes if the analysis targets specific groups of learners. For example, novice learners may benefit more from increased skills practice to improve speed, accuracy, and coordination, afforded by the SBT. The EDA results suggest that the use of this measure can be a valid indicator of arousal and further work in this area is warranted. The affective response or emotional engagement may be an important factor in learning outcomes. This study accomplished an exploratory assessment of the practicality of pursuing this possibility.

The course evaluation interview results provided key perspective of study participants and verified the current prevailing paradigm that training with live tissue is generally preferred by nearly all participants. It was acknowledged by many interviewees that use of LTT can possibly be minimized by using a live animal model when it is expected to have the most impact.

Knowledge Assessment Interpretation of Results

No significant difference was observed in learning outcomes between LTT and SBT with the study sample of 80 participants. It appears likely that it is acceptable to replace the live animal model, the anesthetized ferret, with simulator based training without negatively impacting learning outcomes for pediatric intubation.

Psychomotor Skills Assessment Interpretation of Results

No significant difference was observed in the learning outcomes between LTT and SBT. Anchoring and inter-rater reliability is believed to be strong averaging around 90% in multiple trials (>10) so it is unlikely that this contributed to the lack of a significant difference observed between the two training groups. Also based on the subject matter expert input it is believed that the psychomotor skills checklist is complete and accurate for the pediatric intubation procedure. It is likely that there is not a difference between the two training modalities. This result would indicate that it is acceptable to replace the live animal model, the anesthetized ferret, with simulator based training without negatively impacting psychomotor skills learning outcomes for pediatric intubation.

Self-Efficacy Interpretation of Results

No significant difference was observed in the learning outcomes between LTT and SBT. This result would indicate that it is acceptable to replace the live animal model, the anesthetized ferret, with simulator based training without

negatively impacting psychomotor skills learning outcomes for pediatric intubation.

Electrodermal Activity Measure Interpretation of Results

Use of the Q-sensor device is reliable and appears to provide a valid measure. The device performed as expected with 3 failures (of 80 uses) observed during the study period.

ANOVA of the mean difference of the electrodermal activity (EDA) measure for the simulation-based training group compared to the live tissue training group shows no significant difference between the group that trained with live tissue compared to the group that trained with simulation.

EDA measure is believed to be a valid indicator of arousal or engagement. It is possible that there may be a difference which was not detected in this study because the level of engagement for all participants seemed elevated due to the challenging nature of the procedure that was being trained.

Course Evaluation Interpretation of Results

There was not a significant difference between the two training groups in evaluating the course, the interviews yielded additional information. Generally, participants saw a need to continue using an animal model in this type of training. The use of an animal model could be in combination with simulation for maximum benefit. The course content was consistently very highly rated.

It is clear from the participant interviews that live tissue training remains the preferred modality for training pediatric intubation. This was repeatedly expressed even though the course evaluation survey results revealed no significant difference between LTT and SBT in the perceived value of the training. This could be due, in part, to the prevailing paradigm and attendant expectation that the “feel of live tissue” is necessary for training. From this, it could be argued that the learning process for training pediatric intubation could be more carefully characterized in terms of the components of learning such as knowledge, decision making, emotional reactions, and physical skills. Furthermore, a better understanding and accommodation of the learner, and his or her preferences and experience would also be necessary to more fully utilize SBT, minimizing the use of LTT for procedures. Trainees continue to believe that training with live tissue is perceived to be better than training with simulation.

Key Findings

While the statistical analysis did not show a difference in learning outcomes between the group trained with live tissue compared to the group trained with simulation, several key findings are described which can inform further research in this area. It is believed that further development of the knowledge assessment could improve reliability of the instrument used in this study. The psychomotor skills test is heavily dependent upon accurate description of the actions to be observed and the anchoring of the observer raters. The psychomotor assessment has been a very strong aspect of this study. Use of the EDA measure seems more promising than initially anticipated. While a significant difference between the two training groups was not detected, there did appear to a strong EDA change in some participants who trained with the live tissue training group. It would be helpful to further investigate this response in two ways. First further statistical modeling should be explored with the current study results. Second, in a subsequent study, it would be helpful to understand from those individuals who have a larger change in EDA measure what the underlying cause may be.

Limitations

First it should be noted that this study has undertaken the most comprehensive assessment procedure conducted for any study which evaluates simulation-based training for pediatric intubation. Not only is this one of the first studies to use knowledge, skills and self-efficacy, each of these approaches has been constructed utilizing consensus based decisions in using the current best practices models for performance assessment instruments. Study limitations are summarized with respect to the study design, execution, and analysis of results.

The research study design entailed testing all participants using simulators. A better study design would have tested participants using the live anesthetized ferret and the simulator. If it had been financially feasible, this study could have used a cross over study design in which participants trained and tested with both live anesthetized ferret and the simulator. Also, the participants may have brought a wider heterogeneity of skills, experience, and background than initially anticipated. Subsequently, participant demographics may be a potential confounder. Some participants have many years of training; some have less than a year of training. This study included collection of prior training experience involving live tissue and simulation and this could be further explored in subsequent analysis.

The knowledge assessment could be revised for increased reliability. This could be accomplished by using a subset of questions which focus on decisions made to do the procedure and reduced complexity of the question structure and

grammar. After refining the questions to be included new questions should be added to increase the total number of questions in the knowledge assessment.

The self-efficacy survey asks about confidence in doing the procedure on a simulator or live animal, but does not ask participants about confidence to intubate a human child. This question should be asked in a subsequent study because high self-efficacy for a task increases the likelihood that an individual will attempt the task and successfully achieve it.

Conclusion

The measurement of learning outcomes in this research provides new evidence to support further adoption of simulation technology. This research study has shown no significant differences between the two training groups' learning outcomes in knowledge assessment, psychomotor assessment and self-efficacy for performance of pediatric intubation. The preliminary analysis of the electrodermal activity measure, an indicator of an emotional arousal associated with either model also showed no significant differences between the two groups.

The learning outcomes measures are based on standardized educational objectives and assessments developed from established practices. As such, based on the results of this study, simulation-based training for pediatric intubation should be more widely adopted. This can be accomplished without

diminishing the quality of the training associated with working with a live anesthetized ferret.

This evidence supports further integration of simulation-based training and the reduced use of live animals in medical skills training. It should also be noted that the results of the interviews indicate a widely held strong belief that training with live tissue is superior to training with simulators.

Future Directions

Increased sample size and the addition of future training session data in subsequent analyses may improve the ability to detect a relationship between the assigned training group and the change in scores if a difference between the training modalities exists. The power of the study and ability to detect a very small difference between the training groups could be improved with a larger sample size. This consideration should be weighed against determination of the size of a meaningful difference.

Anticipating that the EDA measurement is non-linear, further analysis of polynomial or nonlinear models is warranted. The relationship between knowledge assessment and EDA measure requires further analysis to better explore the possible relationship between knowledge assessment and arousal.

Further investigation of the use of this measure for simulation, and medical education and training will advance training programs and can optimize the participant training experience and related learning outcomes. This evidence is

needed to support further integration of SBT training and the reduced use of live animals in medical skills training. We anticipate that the results will help ensure that trauma education and training utilizes the most effective training methods available for military personnel.

APPENDIX Study Instruments

Demographic Survey

CCTC CRA3A Neonatal and Pediatric Intubation

<table>
<tr><td colspan="2">Registration Page</td></tr>
<tr><td colspan="2">ID Number:

(Enter- SSN last 4 numbers)</td></tr>
<tr><td colspan="2">Q-Sensor Number:

(Auto listing- 1-20)</td></tr>
<tr><td colspan="2">Audience Response Device Number (if appl):

(Auto listing- 1-20, N/A)</td></tr>
<tr><td colspan="2">Age:

(Enter- Date of birth)</td></tr>
<tr><td colspan="2">Gender:

(Auto listing- Female/Male)</td></tr>
<tr><td colspan="2">Active military, active reserve military, or civilian:

(Auto listing- Active military, active reserve military, civilian)</td></tr>
<tr><td colspan="2">Begin branching based on military or civilian choice</td></tr>
<tr><td>If active or

reserve military:</td><td>If civilian:</td></tr>
</table>

Component code: (Auto listing- all codes)	
Rank: (Auto listing- E1-9, O1-10)	
Military occupation: (Auto listing- may select more than one: Combat Medic, Corpsman, Special Operations Medic, Flight Medic, Pararescue Jumper, Paramedic, Advanced Practice Nurse, Registered Nurse, Physician Assistant, Physician, Surgeon, Flight	Occupation: (Auto listing- Medical Student, Resident, Fellow, Emergency Medical Technician, Paramedic, Licensed Practical Nurse, Registered Nurse, Advanced Practice Nurse, Physician Assistant, Fellow, Physician, Surgeon, Anesthesiologist, Dentist) If you are a medical student, please indicate year of training: (Auto listing: 1st year, 2nd year, 3rd year, 4th year, N/A-I am not a medical student) If you are a resident, please indicate year of training: (Auto listing: PGY1, PGY2, PGY3, PGY4, PGY5, PGY6, PGY7, N/A-I am not a resident)

Surgeon, Anesthesiologist, Dentist, Independent Duty Medical Technician)	
Unit of assignment: (Enter- unit)	
Have you trained on an inanimate simulator? (Auto listing- yes/no)	Have you trained on an inanimate simulator? (Auto listing- yes/no)
Have you trained on a live animal? (Auto listing- yes/no)	Have you trained on a live animal? (Auto listing- yes/no)

Active/Reserve Military Demographic Questions
How many years in duty occupation? (Auto listing- 1-4 years, 5-8 years, 9-14 years, 15 years or greater)
When was last applicable refresher course taken?

(Auto listing- < 3 months, 3 to 12 months, > 12 months)
Have you been deployed to a war zone? (Auto listing- yes/no) If yes, what was your total deployment time: (Auto listing- <6 months, 6 – 12 months, 13-24 months, 24-36 months, > 36 months) If yes, how recently did your deployment end: (Auto listing- <3 months, 3 – 12 months, 13-24 months, > 24 months)
Have you performed treatment during the 'Care Under Fire' phase of Tactical Combat Casualty Care? (Auto listing- yes/no) If yes, how many times: (Auto listing- 1, 2, 3, 4, 5 times or more) If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed treatment during the 'Tactical Field Care' phase of Tactical Combat Casualty Care? (Auto listing- yes/no)

If yes, how many times: (Auto listing- 1, 2, 3, 4, 5 times or more)   If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed treatment during the 'Casualty/Tactical Evacuation' phase of Tactical Combat Casualty Care? (Auto listing- yes/no)   If yes, how many times: (Auto listing- 1, 2, 3, 4, 5 times or more)   If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed treatment for any of the following? (Auto listing- may select more than one of the following: severe arterial bleeding, amputation, blocked airway, chest wounds, gunshot wounds, explosive wounds, chemical agent)

Civilian Demographic Questions
How many years in current occupation: (auto listing- < 1 year, 1-4 years, 5-8 years, 9-14 years, 15 years or greater)
Type of employer: (enter- hospital, school, fire dpt., private practice, urgent care facility, long term care facility)
Have you performed treatment for any of the following? (Auto listing- may select more than one of the following: severe arterial bleeding, amputation, blocked airway, chest wounds, gunshot wounds, explosive wounds)
Have you performed Tactical Emergency Medical Support (TEMS)? (Auto listing- yes/no) If yes, how many times: (Auto listing- 1, 2, 3-5, >5) If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed medical care in a Mass Casualty Incident (MCI)? (Auto listing- yes/no) If yes, how many times:

(Auto listing- 1, 2, 3-5, >5) If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
When was last applicable refresher course taken? (Auto listing- < 3 months, 3 to 12 months, > 12 months)
Have you been deployed to a war zone? (Auto listing- yes/no) If yes, what was your total deployment time: (Auto listing- <6 months, 6 – 12 months, 13-24 months, 24-36 months, > 36 months) If yes, how recently did your deployment end: (Auto listing- <3 months, 3 – 12 months, 13-24 months, > 24 months)
Have you performed treatment during the 'Care Under Fire' phase of Tactical Combat Casualty Care? (Auto listing- yes/no) If yes, how many times:

(Auto listing- 1, 2, 3, 4, 5 times or more) If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed treatment during the 'Tactical Field Care' phase of Tactical Combat Casualty Care? (Auto listing- yes/no) If yes, how many times: (Auto listing- 1, 2, 3, 4, 5 times or more) If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed treatment during the 'Casualty/Tactical Evacuation' phase of Tactical Combat Casualty Care? (Auto listing- yes/no) If yes, how many times: (Auto listing- 1, 2, 3, 4, 5 times or more)

If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)

Demographic Questions
CRA 3A Neonatal/Pediatric Intubation Skills Only (Same For Military & Civilian Students)
Have you performed a pediatric intubation on a human? (Auto listing- yes/no) If yes, how many times: (Auto listing- 1, 2, 3-5, >5) If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed a pediatric intubation on a live animal? (Auto listing- yes/no)

If yes, how many times: (Auto listing- 1, 2, 3-5, >5)   If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed a pediatric intubation on a patient simulator? (Auto listing- yes/no)   If yes, how many times: (Auto listing- 1, 2, 3-5, >5)   If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed a pediatric intubation on a partial task trainer? (Auto listing- yes/no)

If yes, how many times: (Auto listing- 1, 2, 3-5, >5)   If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed a neonatal intubation on a human? (Auto listing- yes/no)   If yes, how many times: (Auto listing- 1, 2, 3-5, >5)   If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed a neonatal intubation on a live animal? (Auto listing- yes/no)   If yes, how many times:

(Auto listing- 1, 2, 3-5, >5) If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed a neonatal intubation on a patient simulator? (Auto listing- yes/no) If yes, how many times: (Auto listing- 1, 2, 3-5, >5) If yes, how recently: (Auto listing- <3 months, 3 – 12 months, > 12 months)
Have you performed a neonatal intubation on a partial task trainer? (Auto listing- yes/no) If yes, how many times: (Auto listing- 1, 2, 3-5, >5)

If yes, how recently:

(Auto listing- <3 months, 3 – 12 months, > 12 months)

Knowledge Assessment

Which of the following is an accepted method for determination of proper endotracheal tube size in pediatric/neonatal patients?	The internal tube diameter is approximately the width of the child's pinky finger.	1	Pre
SAME - 1. KNOWLEDGE	The formula (Age in years / 4) + 3 can be used to guide internal tube diameter selection for uncuffed tubes.	0	Pre
	The formula (Age in years / 4) + 4 can be used to guide internal tube diameter selection for cuffed tubes.	0	Pre
	Cuffed tubes are generally selected to be 2 full sizes smaller than uncuffed tubes.	0	Pre
	None of the above are correct.	0	
When using a colorimetric carbon dioxide detector, the color that	Purple.	0	Pre

indicates the presence of expired carbon dioxide is:			
USE of EQUIPMENT:	Tan.	0	Pre
	Yellow.	1	Pre
	Blue.	0	Pre
	Red.	0	Pre
Which of the following equipment is not essential for intubation of a pediatric/neonatal patient?	Endotracheal tube malleable stylet.	1	Pre
PROCEDURE:	Appropriately sized bag-valve mask.	0	Pre
	Laryngoscope handle.	0	Pre
	Laryngoscope blade.	0	Pre
	All of the above are essential.	0	Pre
Which of the following statements is correct regarding expired carbon dioxide detection in the setting of endotracheal intubation?	(a) A colorimetric detector may take 5-6 breaths to register an observable color change.	0	Pre

USE OF EQUIPMENT	(b) Detection of carbon dioxide guarantees proper depth of insertion.	0	Pre
	(c) It can be used to continuously monitor endotracheal tube placement.	0	Pre
	All of the above are correct.	0	
	Only (a) and (b) are correct.	1	Pre
Which of the following would be considered the best secondary method to confirm tracheal placement of an endotracheal tube?	Visualization of bilaterally symmetric chest rise and fall.	0	Pre
5. PROCEDURE: IN RED	Condensation in the endotracheal tube on exhalation.	0	Pre
	Lack of air sounds in the stomach.	0	Pre
	Presence of breath sounds	0	Pre

	on both sides of the chest.		
	Detection of expired carbon dioxide.	1	Pre
Which of the following are true regarding pediatric/neonatal airway anatomy compared to adult airway anatomy?	The adult larynx is funnel shaped.	0	Pre
KNOWLEDGE:	The pediatric/neonatal tongue is relatively large compared to the adult tongue.	1	Pre
	The adult epiglottis is short and stubby compared to the pediatric/neonatal epiglottis.	0	Pre
	The glottic opening is higher and more anterior in adults.	0	Pre
	All of the above are true.	0	Pre
A 5.0 ID cuffed endotracheal tube was just inserted into an 8 year old child and colorimetric carbon	Until the 15 cm mark on the tube is at the child's teeth or lips.	1	Pre

dioxide detection has confirmed tracheal placement. To what depth should the endotracheal tube be inserted?			
PROCEDURE:	Until the 18 cm mark on the tube is at the child's teeth or lips.	0	Pre
	As far as possible to decrease the risk of dislodgement.	0	Pre
	Until the 12 cm mark on the tube is at the child's teeth or lips.	0	Pre
	Until breath sounds can be auscultated on each side of the chest.	0	Pre
Which of the following is true regarding laryngoscopes and their use in pediatric/neonatal intubation?	The laryngoscope is held in the dominant hand.	0	Pre

USE OF EQUIPMENT: IN RED	The Macintosh blade is always preferred for neonatal intubation.	0	Pre
	The Miller blade is placed directly on the epiglottis.	1	Pre
	The Macintosh blade is straight.	0	Pre
	None of the above is true.	0	Pre
Which of the following characteristics of the pediatric/neonatal airway make it more susceptible to obstruction than the adult airway?	The funnel shape of the pediatric/neonatal larynx.	0	Pre
9.9. KNOWLEDGE:	The presence of relatively thicker vocal cords.	0	Pre
	The higher and more anterior location of the glottic opening.	0	Pre
	The smaller diameter trachea.	1	Pre

	None of the above is correct.	0	Pre
Which of the following is true regarding laryngoscope blade selection in children?	The Macintosh blade is placed directly on the epiglottis resulting in better visualization of the glottis.	0	Pre
KNOWLEDGE:	Damage to the teeth is less likely when using a Macintosh blade.	0	Pre
	Choice of blade is based on personal preference.	1	Pre
	The side of the mouth that the blade is inserted is determined by blade type.	0	Pre
	Miller blades are not made in sizes appropriate for this patient population.	0	Pre
Which of the following best characterizes the correct use of cuffed endotracheal tubes in pediatric/neonatal patients?	The cuff is inflated until the pilot balloon is completely full.	0	Pre

USE of EQUIPMENT:	The cuff should be fully inflated to prevent the endotracheal tube from becoming inadvertently dislodged.	0	Pre
	The cuff should be inflated regardless of the presence of a leak.	0	Pre
	Cuffed endotracheal tubes are not recommended in this patient population.	0	Pre
	None of the above are correct.	1	Pre
Which of the following is true regarding the correct sequence of intubation steps in pediatric/neonatal patients?	The inserted endotracheal tube should be secured in place prior to confirmation of tracheal placement to prevent inadvertent dislodgement.	0	Pre
PROCEDURE:	The laryngoscope is grasped in the left hand and the	1	Pre

	endotracheal tube is inserted using the right hand.		
	A colorimetric carbon dioxide detector can be attached either directly to the endotracheal tube or downstream of the bag-valve mask.	0	Pre
	All of the above are true.	0	Pre
	None of the above are true.	0	Pre
Order the following list of pediatric/neonatal intubation steps in the correct sequence: (1) Secure the tube with tape or endotracheal tube securing device (2) Assemble and check all necessary equipment (3) Attach expired carbon dioxide detector (4) Insert the endotracheal tube through the glottis	2, 5, 7, 4, 8, 3, 1, 6	0	Pre

(5) Open the mouth using the right hand scissor technique (6) Inflate the endotracheal tube cuff at the correct depth of insertion (7) Insert the laryngoscope (8) Attach the bag valve mask and give the patient breaths			
PROCEDURE: ALL Qs the SAME to this point	2, 5, 7, 4, 3, 8, 6, 1	1	Pre
	2, 5, 7, 4, 3, 8, 1, 6	0	Pre
	2, 5, 7, 3, 4, 8, 6, 1	0	Pre
	2, 7, 5, 4, 8, 3, 6, 1	0	Pre
All of the following are true regarding the use of an endotracheal tube malleable stylet EXCEPT:	A properly inserted stylet does not extend beyond the endotracheal tube tip.	0	Pre
SAME 14. USE OF EQUIPMENT	Care must be taken when removing a stylet from an endotracheal tube to avoid displacement of a properly	0	Pre

	positioned endotracheal tube.		
	A bag-valve mask will not attach to an endotracheal tube with a stylet in it.	0	Pre
	In pediatric patients the decision to use a stylet is based on the preference of the person performing the intubation.	0	Pre
	In neonatal patients a stylet should always be used to facilitate endotracheal intubation given their high and anterior airways.	1	Pre
Pick the BEST method of intubation with a Miller blade:	Insert laryngoscope blade on patient's right side of mouth, sweep tongue to the left, place blade in the vallecula behind the epiglottis, keep wrist straight and lift forward	0	Pre

	to visualize the glottis.		
SAME PROCEDURE IN RED	Insert laryngoscope blade on patient's right side of mouth, sweep tongue to the left, place blade on the epiglottis, keep wrist straight and lift forward to visualize the glottis.	1	Pre
	Insert laryngoscope blade on either side of the mouth depending on your dominant hand, place blade in the vallecula behind the epiglottis, keep wrist straight and lift forward to visualize the glottis.	0	Pre
	Insert laryngoscope blade on patient's left side of mouth, sweep tongue to the right, place blade on the epiglottis, bend wrist backwards to	0	Pre

	visualize the glottis.		
	Insert laryngoscope blade on patient's left side of mouth, sweep tongue to the right, place blade behind the epiglottis in the vallecula, keep wrist straight and lift forward to visualize the glottis.	0	Pre
Which of the following is true regarding preparation and positioning of the pediatric/neonatal patient for endotracheal intubation?	In very young patients, placing a towel under the shoulders will facilitate placing the patients head in the "sniffing" position.	0	Pre
PROCEDURE:	Pre-oxygenation is recommended in all patients prior to attempting intubation.	0	Pre
	The sniffing position aligns the oral, pharyngeal, and tracheal axes to facilitate	0	Pre

	vocal cord visualization and intubation.		
	The sniffing position is attained by tilting the patient's head and lifting their chin.	0	Pre
	All of the above are true.	1	Pre
Which of the following is true regarding differences between the pediatric/neonatal and adult airways?	The cricoid ring is the narrowest part of the adult airway.	0	Pre
	The pediatric/neonatal epiglottis is more angled over the laryngeal inlet than the adult epiglottis.	1	Pre
KNOWLEDGE:	A child older than 4 years old has an airway similar to an adult.	0	Pre
	The vocal cords in adult patients are relatively more	0	Pre

	angled.		
	None of the above are true.	0	Pre
Which of the following is true regarding the use of cricoid pressure in pediatric/neonatal patients?	(a) The purpose of cricoid pressure is to prevent aspiration and should always be applied.	0	Pre
	(b) Cricoid pressure does not eliminate the risk of aspiration.	0	Pre
KNOWLEDGE: IN RED	(c) Cricoid pressure may either aid or hinder visualization of the pediatric neonatal larynx.	0	Pre
	Both (a) and (c) are correct.	0	Pre
	Both (b) and (c) are correct.	1	Pre
What is the recommended duration of pre-oxygenation with 100% oxygen in pediatric/neonatal patients?	1-2 minutes.	0	Pre
19. PROCEDURE	2-4 minutes.	1	Pre

	4-8 minutes.	0	Pre
	Only a single breath of 100% is required.	0	Pre
	5-6 minutes.	0	Pre
Which of the following are acceptable methods to determine appropriate depth of endotracheal tube insertion?	Adjusting the distance markings on the tube such that 4 times the tube size is aligned with the lips or teeth.	0	Pre
20 PRE TEST: PROCEDURE	Inserting the tube until the vocal cord depth markers are at the glottic opening.	1	Pre
	Noting the presence of sufficient expired breath condensate on the tube interior insures proper depth of insertion.	0	Pre
	All of the above methods can be used.	0	Pre
	None of the above should be used.	0	Pre

Which of the following is an accepted method for determination of proper endotracheal tube size in pediatric/neonatal patients?	The internal tube diameter is approximately the width of the child's pinky finger.	1	Post
	The formula (Age in years / 4) + 3 can be used to guide internal tube diameter selection for uncuffed tubes.	0	Post
	The formula (Age in years / 4) + 4 can be used to guide internal tube diameter selection for cuffed tubes.	0	Post
	Cuffed tubes are generally selected to be 2 full sizes smaller than uncuffed tubes.	0	Post
	None of the above are correct.	0	Post
When using a colorimetric carbon dioxide detector, the color that indicates the presence of expired	Purple.	0	Post

carbon dioxide is:			
	Tan.	0	Post
	Yellow.	1	Post
	Blue.	0	Post
	Red.	0	Post
Which of the following equipment is not essential for intubation of a pediatric/neonatal patient?	Endotracheal tube malleable stylet.	1	Post
	Appropriately sized bag-valve mask.	0	Post
	Laryngoscope handle.	0	Post
	Laryngoscope blade.	0	Post
	All of the above are essential.		
Which of the following statements is correct regarding expired carbon dioxide detection in the setting of endotracheal intubation?	(a) A colorimetric detector may take 5-6 breaths to register an observable color change.	0	Post

	(b) Detection of carbon dioxide guarantees proper depth of insertion.	0	Post
	(c) It can be used to continuously monitor endotracheal tube placement.	0	Post
	All of the above are correct.	0	Post
	Only (a) and (b) are correct.	1	Post
Which of the following would be considered the most reliable method to confirm tracheal placement of an endotracheal tube?	Direct visualization of endotracheal tube insertion through the vocal cords.	1	Post
	Absence of gastric distention following bag-valve mask ventilation.	0	Post
	Condensation in the endotracheal tube on exhalation.	0	Post

	Presence of breath sounds on both sides of the chest.	0	Post
	None of the above are correct.	0	Post
Which of the following are true regarding pediatric/neonatal airway anatomy compared to adult airway anatomy?	The adult larynx is funnel shaped.	0	Post
SAME as #6	The pediatric/neonatal tongue is relatively large compared to the adult tongue.	1	Post
	The adult epiglottis is short and stubby compared to the pediatric/neonatal epiglottis	0	Post
	The glottic opening is higher and more anterior in adults.	0	Post
	All of the above are true.	0	Post
A 4.0 ID endotracheal tube was just inserted into a 4 year old child	As far as necessary to leave only 4 cm of tube outside the	0	Post

and expired carbon dioxide detection has confirmed tracheal placement. Prior to securing the tube with tape, how far should you insert this tube?	mouth.		
	Until the 15 cm mark on the tube is at the child's lips.	0	Post
	Until the 12 cm mark on the tube is at the child's teeth or lips.	1	Post
	Until the 18 cm mark on the tube is at the child's teeth.	0	Post
	Any of the above answers is acceptable.	0	Post
Which of the following is true regarding bag-valve mask ventilation of pediatric/neonatal patients?	(a) The most appropriate size bag for neonatal patients is 250 mL.	0	Post
laryngoscope in pre-test	(b) The most appropriate size bag for pediatric	0	Post

	patients is 250 mL.		
	(c) An appropriate oxygen flow rate is 10-15 liters per minute.	0	Post
	Both (a) and (c) are correct.	1	Post
	All of the above are correct.	0	Post
Which of the following characteristics of the pediatric/neonatal airway make it more susceptible to obstruction than the adult airway?	The funnel shape of the pediatric/neonatal larynx.	0	Post
	The presence of relatively thicker vocal cords.	0	Post
	The higher and more anterior location of the glottic opening.	0	Post
	The smaller diameter trachea.	1	Post
	None of the above are correct.	0	Post

Which of the following is true regarding laryngoscope blade selection in children?	The Macintosh blade is placed directly on the epiglottis resulting in better visualization of the glottis.	0	Post
	Damage to the teeth is less likely when using a Macintosh blade.	0	Post
	Choice of blade is based on personal preference.	1	Post
	The side of the mouth that the blade is inserted is determined by blade type.	0	Post
	Miller blades are not made in sizes appropriate for this patient population.	0	Post
Which of the following best characterizes the correct use of cuffed endotracheal tubes in pediatric/neonatal patients?	The cuff is inflated until the pilot balloon is completely full.	0	Post
	The cuff should be fully inflated to prevent the	0	Post

	endotracheal tube from becoming inadvertently dislodged.		
	The cuff should be inflated regardless of the presence of a leak.	0	Post
	Cuffed endotracheal tubes are not recommended in this patient population.	0	Post
	None of the above are correct.	1	Post
Which of the following is true regarding the correct sequence of intubation steps in pediatric/neonatal patients?	The inserted endotracheal tube should be secured in place prior to confirmation of tracheal placement to prevent inadvertent dislodgement.	0	Post
	The laryngoscope is grasped in the left hand and the endotracheal tube is inserted using the right hand.	1	Post

	A colorimetric carbon dioxide detector can be attached either directly to the endotracheal tube or downstream of the bag-valve mask.	0	Post
	All of the above are true.	0	Post
	None of the above are true.	0	Post
Order the following list of pediatric/neonatal intubation steps in the correct sequence: (1) Secure the tube with tape or endotracheal tube securing device (2) Assemble and check all necessary equipment (3) Attach expired carbon dioxide detector (4) Insert the endotracheal tube through the glottis (5) Open the mouth using the right hand scissor technique (6) Inflate the endotracheal tube	2, 5, 7, 4, 8, 3, 1, 6	0	Post

cuff at the correct depth of insertion (7) Insert the laryngoscope (8) Attach the bag valve mask and give the patient breaths			
	2, 5, 7, 4, 3, 8, 6, 1	1	Post
	2, 5, 7, 4, 3, 8, 1, 6	0	Post
	2, 5, 7, 3, 4, 8, 6, 1	0	Post
	2, 7, 5, 4, 8, 3, 6, 1	0	Post
All of the following are true regarding the use of an endotracheal tube malleable stylet EXCEPT:	A properly inserted stylet does not extend beyond the endotracheal tube tip.	0	Post
	Care must be taken when removing a stylet from an endotracheal tube to avoid displacement of a properly positioned endotracheal tube.	0	Post

	A bag-valve mask will not attach to an endotracheal tube with a stylet in it.	0	Post
	In pediatric patients the decision to use a stylet is based on the preference of the person performing the intubation.	0	Post
	In neonatal patients a stylet should always be used to facilitate endotracheal intubation given their high and anterior airways.	1	Post
Which of the following is the best sequence of intubation steps when using a Macintosh blade?	Insert laryngoscope blade on patient's right side of mouth, sweep tongue to the left, place blade in the vallecula behind the epiglottis, keep wrist straight and lift forward to visualize the glottis.	1	Post
	Insert laryngoscope blade on	0	Post

	patient's right side of mouth, sweep tongue to the left, place blade on the epiglottis, keep wrist straight and lift forward to visualize the glottis.		
	Insert laryngoscope blade on either side of the mouth depending on your dominant hand, place blade on the epiglottis, keep wrist straight and lift forward to visualize the glottis.	0	Post
	Insert laryngoscope blade on patient's left side of mouth, sweep tongue to the right, place blade on the epiglottis, bend wrist backwards to visualize the glottis.	0	Post
	Insert laryngoscope blade on patient's right side of mouth, sweep tongue to the left,	0	Post

	place blade on the epiglottis, bend wrist backwards to visualize the glottis.		
Which of the following is true regarding preparation and positioning of the pediatric/neonatal patient for endotracheal intubation?	In very young patients, placing a towel under the shoulders will facilitate placing the patients head in the “sniffing” position.	0	Post
	Pre-oxygenation is recommended in all patients prior to attempting intubation.	0	Post
	The sniffing position aligns the oral, pharyngeal, and tracheal axes to facilitate vocal cord visualization and intubation.	0	Post
	The sniffing position is attained by tilting the patient’s head and lifting their chin.	0	Post

	All of the above are true.	1	Post
Which of the following is true regarding differences between the pediatric/neonatal and adult airways?	The cricoid ring is the narrowest part of the adult airway.	0	Post
	The pediatric/neonatal epiglottis is more angled over the laryngeal inlet than the adult epiglottis.	1	Post
	A child older than 4 years old has an airway similar to an adult.	0	Post
	The vocal cords in adult patients are relatively more angled.	0	Post
	None of the above are true.	0	Post
Which of the following is true regarding the selection of appropriate equipment for pediatric/neonatal intubation?	(a) A proper sized mask covers the area from the bridge of the nose to the chin.	1	Post

	(b) A bag-valve mask breath should be terminated once maximum chest rise is attained.	0	Post
	(c) Carbon dioxide detection is the single most reliable method for confirmation of tracheal placement of an endotracheal tube.	0	Post
	Both (a) and (c) are true.	0	Post
	None of the above are true.	0	Post
What is the recommended duration of pre-oxygenation with 100% oxygen in pediatric/neonatal patients?	1-2 minutes.	0	Post
	2-4 minutes.	1	Post
	4-8 minutes.	0	Post
	Only a single breath of 100% is required.	0	Post
	5-6 minutes.	0	Post

Which of the following are true regarding physiologic differences between pediatric/neonatal and adult patients?	(a) Adult and pediatric patients take about the same amount of time to desaturate.	0	Post
KNOWLEDGE	(b) Pediatric patients have higher metabolic oxygen consumption and therefore must be pre-oxygenated for longer than adults.	0	Post
	(c) Bag-valve mask ventilation is more likely to produce gastric distention in adults.	0	Post
	Both (b) and (c) are correct.	0	Post
	None of the above is true.	1	Post

This page left intentionally blank.

Psychomotor Checklist

Task	Priority	Steps	Step Critical
Body substance isolation	1	Put on gloves	0
Assemble equipment	1	Appropriately sized laryngoscope and blade	1
	1	Appropriately sized ETT	1
	1	Airway suction device	0
	1	Appropriately sized BVM	1
	1	Stethoscope	0
	1	Colorimetric CO2 detector	0
	1	Flexible stylet	0
	1	5-10 mL syringe	1
Prepare and inspect equipment	1	Attaches laryngoscope handle and blade	1

	1	Confirms functional laryngoscope light source	1
	1	Uses syringe to inflate/deflate ETT cuff	0
	1	Inserts stylet into ETT (if stylet is used)	0
	1	Stylet not protruding from ETT tip and stylet/ETT correctly bent (if stylet is used)	1
	1	Turns on oxygen source and confirms flow	0
	1	Connects oxygen source to BVM	0
	1	Confirms functional suction at head of bed	0
Position/prepare the patient	1	Connects patient to ECG, SpO2, and NIBP monitors if available	0
	1	Pre-oxygenates with mask and 100% oxygen for 2-4 minutes	0
	1	Requests administration of drugs (if used)	0
	1	Places head in neutral or sniffing position	1
	1	Ventillates with BVM using appropriate technique	1
Insert and	1	Trainee initiates breath hold at	1

advance laryngoscope		discontinuation of BVM ventilation	
	1	Grasps laryngoscope with left hand	1
	1	Scissor technique to open mouth with right hand	0
	1	Inserts laryngoscope blade on the casualty's right side of mouth	0
	1	Displaces/sweeps tongue to the left	0
	1	Advances laryngoscope using proper "lift up" technique	1
Visually identify the epiglottis and vocal cords	1	Verbally identifies vocal cord visualization	1
	1	Keeps cords in view - continuous visualization (doesn't look away)	0
	1	Grasps ETT in right hand (with assistance)	1
Intubation	1	Inserts the ETT	1
	1	Removes stylet if stylet utilized for intubation	1

	1	Attaches the BVM and ventilates using appropriate technique	1
	1	Completes above tasks prior to midway through breath hold; if tasks not complete, returns to BVM ventilation followed by second attempt	1
	1	Adjusts depth of ETT insertion using appropriate guidelines	0
Cuff inflation	1	Inflates cuff with syringe (if necessary) using minimum occlusive pressure technique	0
	1	Does not overinflate	0
Confirm appropriate placement	1	Attaches CO2 detector	0
	1	Attaches BVM (or leaves attached if CO2 detector omitted) and provides IPPV	1
	1	Identifies CO2 register on detector	0
	1	Identifies chest rise and fall	1

	1	Identifies condensate in tube	0
	1	Identifies presence of breath sounds with stethoscope	0
	1	Identifies absence of abdominal sounds with stethoscope	0
Secure ETT	1	Secures ETT without displacement or movement	1
Reconfirm ETT placement	1	Attaches BVM and provides manual ventilation	0
	1	Identifies chest rise and fall	0
	1	Identifies presence of breath sounds with stethoscope	0
	1	Identifies absence of abdominal sounds with stethoscope	0

Self-Efficacy Survey

Critical Research Area 3 A-Neonatal/Pediatric Intubation

On a scale from 0% to 100%, please rate your degree of confidence in performing the following procedures accurately and efficiently.

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

No confident

Extremely confident

1. Hemorrhage Control: Apply tightly and secure a Combat Application Tourniquet (CAT) with a windlass clip.
2. Chest Tube Insertion: Prepare the insertion site to perform a chest tube insertion.

3. Cholinergic Crisis: Identify signs and symptoms of mild, moderate, and severe cases of nerve agent exposure and administer appropriate antidote.
4. Identify the relevant indications for endotracheal intubation of the neonatal/pediatric patient.

5. Position and prepare a neonatal/pediatric patient (appropriate pre-oxygenation, drug administration, and non-invasive ventilation) for endotracheal intubation.

6. Select equipment appropriate for endotracheal intubation of a neonatal/pediatric patient.

7. Identify and select an appropriately-sized cuffed endotracheal tube for a neonatal/pediatric patient.

8. Insert a laryngoscope from the correct position in a neonatal/pediatric patient.

9. Use the “lift up” maneuver before advancing the laryngoscope to aid visualization of the vocal cords in a neonatal/pediatric patient.

10. Insert the endotracheal tube into the trachea and inflate the cuff.

11. Confirm correct placement of an endotracheal tube by auscultation of bilateral breath sounds and observation of bilateral chest wall movement.

12. Perform neonatal/pediatric intubation on a patient simulator.

13. Perform neonatal/pediatric intubation on a live animal.

14. Perform neonatal/pediatric intubation on a partial task-trainer.

This page intentionally let blank.

Course Evaluation

Evaluation of CRA3A-Neonatal/Pediatric Intubation Training

How Much Do You Agree? Please rate the percentage of your agreement with the following statements:

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

Example: How much do you agree that the American voters will select a Republican in the November elections?

- Strongly Disagree
- Disagree
- Agree ← This student agrees that the American voters will select a Republican in the November elections.

- Strongly Agree

1. The narrated slide presentation was the most important part of the training for me.
2. I learned the most about neonatal/pediatric intubation from the hands-on training experience with the live animal. (Group working with ferret)
3. I learned the most about neonatal/pediatric intubation from the hands-on training experience with the patient simulator. (Group working with simulator B)
4. I don't need to work with a live animal to learn neonatal/pediatric intubation procedures since patient simulators offer a good training platform for me. (Group working with simulator B)
5. I don't need to work with a patient simulator to learn neonatal/pediatric intubation procedures since live animals offer a good training platform for me. (Group working with ferret)
6. I was able to best demonstrate my knowledge on the multiple-choice assessment.
7. I was able to best demonstrate my knowledge on the patient simulator performance exercise towards the end of the training.
8. Training with live animals is the best way for me to learn neonatal/pediatric intubation procedures.
9. Training with patient simulators is the best way for me to learn neonatal/pediatric intubation procedures.

10. I needed the combination of the narrated slide presentation with hands-on training to learn neonatal/pediatric intubation procedures.

Item	Group A-Working with Ferret	Group B-Group Working with Simulator B
1.	✓	✓
2.	✓	
3.		✓
4.		✓
5.	✓	
6.	✓	✓
7.	✓	✓
8.	✓	✓
9.	✓	✓
10.	✓	✓
Total-	8	8

C. CRA 3A-Interviews with individuals or focus groups: Interviews with selected individuals or groups in a focus group (e.g., Investigate outlier scores, students who attracted attention of instructors, etc.) 10 minutes, using the table below for brief notes or recorded for later note-taking. For example, if the participant makes a strongly stated, positive comment, you would briefly record it in the appropriate box as seen below. It is important to stress that the interview questions are anonymous. Below are some sample questions, but there are many possible approaches.

l. With open-ended questions, explore outlier scores. Ask: “Tell me your thoughts about this question about training with a live animal. Could you tell me more? Do you mean that….?”

2. You trained with a patient simulator today. Could you tell me about your experience?

Or

You trained with a live animal today. Could you tell me about your experience?

3. “What part of today’s training worked the best for you? The least? How would you change the training structure to make it more effective for you?”

4. “What was going through your mind when you trained with the live animal?

or

What was going through your mind when you trained with the patient simulator?”

5. “What were your lingering questions after you saw the narrated slide presentation before the actual training session with the instructor?”

6. “At several points during the training, you were administered some multiple choice questions and, at other points, your instructor asked you to demonstrate your skill on a performance evaluation. Which evaluation approach allowed you to best demonstrate your knowledge and skills?”

7. “In your opinion, what was the major benefit of training with a live animal?”

8. “In your opinion, what was the major benefit of training with a patient simulator?”

	POSITIVE	NEGATIVE

WEAK		
STRONG	“I learned a lot from the video presentation and it was really reinforced when we demonstrated our understanding on the simulator.”	

REFERENCES

1. Foster RF, Embrey EP, Smith DJ, Final Report on the Use of Live Animals in Medical Education and Training Joint Analysis Team, Prepared for USD (AT&L), Department of Defense, July 2009.

2. Gawande A. Casualties of war: military care for the wounded from Iraq and Afghanistan. N Engl J Med. 2004; 351(24):2471-2475.

3. Peake JB. Beyond the Purple Heart: continuity of care for the wounded in Iraq. *N* Engl J Med. 2005; 352(3):219-222.

4. Pruitt BA Jr. Combat casualty care and surgical progress. Ann Surg. 2006; 243(6):715-729.

5. Byrne TJ, Hurst CG, Madsen JM, Maliner BI, Whitmer D, Stutler SA, Talbot TR, Nelson J, Lee R, Boehm D, Schulteiss PJ. Graduate Education and Simulation Training for CBRNE Disasters Using a Multi-modal Approach to Learning, Part 1-Education and Training from a Human-Performance Perspective. 2010.

6. Phaal R, Farrukh CJP, Probert DR. Technology Roadmapping—A planning framework for evolution and revolution, Technology Forecasting and Social Change 2004; 71:5-26.

7. Kotwal RS, et al. Eliminating Preventable Death on the Battlefield. Arch Surgery 2011; 146(12):1350-1358.

8. Kotwal RS, 2011

9. Litteral DJ. Performs as Advertised. (Unpublished editorial). Ft. Sam Houston: AMEDD NCO Academy, 2010.

10. Kyle RR, Via DK, Lowy RJ, Madsen JM, Marty AM, Mongan PD. A multidisciplinary approach to teach responses to weapons of mass destruction and terrorism using combined simulation modalities. J Clin Anesth 2004; 16(2):152-8.

11. Byrne TJ, 2010.

12. Byrne TJ. 2010.

13. Carmont MR. The Advanced Trauma Life Support course: a history of its development and review of related literature. Postgrad Med J. 2005; 81:87-91.

14. Hill D, Stalley P, Pennington D, et al. Competency-based learning in traumatology. Am J Surg. 1997; 173:136-140.

15. Alexander GI, Studies in Health Technology and Informatics. The Nurse Patient Trajectory Framework. 910-914.2007.

16. Saleem JJ, Russ AL, Sanderson P, Johnson TR, Zhang J, Sittig DF. Current Challenges and Opportunities for Better Integration of Human Factors Research, Yearbook Med Inform 2009:48-58.

17. Sittig DF, Singh H. A new sociotechnical model for studying health information technology in complex adaptive healthcare systems. Qual Saf Health Care 2010; 19(suppl 3): i68-i74.

18. Alexander GL, 2007.

19. Alexander GL, 2007.

20. Benner P, Tanner CA & Chesla C.A. From beginner to expert: gaining a differentiated clinical world in critical care nursing. Advances in Nursing Science 1992; 14: 13–28.

21. Courtney KL, Alexander GL, Demiris G. Information technology from novice to expert: implementation Implications. Journal of Nursing Management, 2008; 16: 692–699.

22. McGaghie WC, Issenberg, SB, Petrusa ER, Scalese RJ. A critical review of simulation-based medical education research 3003-2009. Medical Education 2010; 44: 50-63.

23. Lawlor M. Post-Terrorist-Attack Triage Teams Rehearse on Virtual-World Platform. Signal Magazine 2000, Available at: **http://www.afcea.org/signal/articles/anmviewer.asp?a=683&print=yes**, accessed 06/06/12.

24. Clark D. Learning Domains, Bloom's Taxonomy. (On-line). 2010; (cited 2012 Oct 28); Available at **http://www.nwlink.com/~donclark/hrd/bloom.html**, accessed 06/01/12

25. Joels M, Pu Z, Wiegert O, Oitzl M, Kruger H. Learning under stress: How does it Work? Trends in Cognitive Sciences 2006; 10:4: 152-158.

26. Lindau M, Almkvist O, Mohammed A. Effects of Stress on Learning and Memory, Encyclopedia of Stress; 2nd Ed., Philadelphia: Elsevier Inc.; 2007. p. 571-577.

27. Ganong W, Review of Medical Physiology, 21st Ed., Lange Medical Books, McGraw Hill, Medical Publishing Division, 2003. p209-215.

28. Byrne TJ, 2010

29. Nixon, P. Stress Performance Curve. The Practioner (On-Line). 1979; (cited 2012 Oct 28); Available at: http://www.experiment-resources.com/how-does-stress-affect-performance.html, accessed 06/01/12

30. Selye H, 1956

31. Yerkes RM, Dodson JD. The relation of strength of stimulus to rapidity of habit-formation. Journal of Comparative Neurology and Psychology 1908; 18: 459–482.

32. Byrne TJ, 2010

33. Kyle RR, 2004

34. Wiener E, Nagel D, Caro P. Human Factors in Aviation: Flight Training and Simulation, Academic Press 1988. 8:229-260.

35. Cook DA, et al., Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. JAMA 2011; 306(9): 978-988.

36. McGaghie WC, 2010

37. Berkenstadt H, Arad M, Nahtomi O, Atsmon J. The effect of a chemical protective ensemble on intravenous line insertion by emergency medical technicians, Mil Med 1999; 164(10): 737-9.

38. Roberts JR, Hedges JR. Clinical Procedures in Emergency Medicine. 5th ed. Philadelphia: WB Saunders Elsevier. 2010.

39. U.S. Congress. House. Battlefield Excellence through Superior Training Practices Act, H.R. 1417. 112th Cong., 1st Sess. (April 07, 2011).
http://www.govtrack.us/congress/bills/112/hr1417/text, (accessed 10/28/12).

40. Department of Defense. Petition for Enforcement. June 2009.Washington DC: Physicians Committee for Responsible Medicine, Available at: http://bloximages.chicago2.vip.townnews.com/nctimes.com/content/tncms/assets/v3/editorial/2/7f/27f0a90a-837b-11de-90cb-001cc4c002e0/27f0a90a-837b-11de-90cb-001cc4c002e0.pdf.pdf, accessed 10/28/12.

41. Galloway S. Alternatives to the use of live animals in military medical trauma training. (Master's Degree Thesis). Ft. Leavenworth, KS: U.S. Army Command and General Staff College, 2000.

42. U.S. Congress. House. Battlefield Excellence through Superior Training Practices Act, H.R. 1417. 112th Cong., 1st Sess. (April 07, 2011). http://www.govtrack.us/congress/bills/112/hr1417/text,(accessed 10/28/12).

43. "Animal Welfare". Code of Federal Regulations Title 9 Pt. 1-3, 55.32,1989. http://awic.nal.usda.gov/government-and-professional-resources/federal-laws/animal-welfare-act, accessed 10/28/12).

44. Sohn VY, et al., From the Combat Medic to the Forward Surgical Team: The Madigan Model for Improving Trauma Readiness of Brigade Combat Teams Fighting the Global War on Terror, Journal of Surgical Research 2007; 138:25-31.

45. Ritter ME, Bowyer MW. Simulation for Trauma and Combat Casualty Care, Minimally Invasive Therapy 2005; 14:4-5: 224-234.

46. Jacobs LM, Burns KJ, Stephen S, Marshall WT. Follow-Up Survey of Participants Attending the Advance Trauma Operative Management (ATOM) Course. J Trauma 2005; 58:6.

47. Byrne TJ, 2010

48. Berkenstadt H, 1999

49. Meehan M, Insko B, Whitton M, Brooks FP. Physiological Measures of Presence in Stressful Virtual Environments, Association for Computing Machinery, Inc.; 2002.

50. Schuetz M, Gockel I, Beardi J, Hakman P, Dunschede F, Moenk S, et al. Three different types of surgeon-specific stress reactions identified by laparoscopic simulation in a virtual scenario. Surg Endosc 2008; 22:1263-7.

51. Berkenstadt H, 1999

52. Hendler I, Nahtomi O, Segal E, Perel A, Wiener M, Meyerovitch J. The effect of full protective gear on intubation performance by hospital medical personnel. Mil Med 2000; 165(4):272-4.

53. Fine BJ, Kobrick JL. Effect of heat and chemical protective clothing on cognitive performance, Aviat Space Environ Med 1987; 58(2):149-54.

54. King JM, Frelin AJ. Impact of the chemical protective ensemble on the performance of basic medical tasks. Mil Med 1984; 149(9):496-501.

55. Arad M, Berkenstadt H, Zelingher J, Laor A, Shemer J, Atsmon J. The effects of continuous operation in a chemical protective ensemble on the performance of medical tasks in trauma management, J Trauma 1993; 35(5):800-4.

56. DeLoach SB, Greenlaw SA. Effectively moderating electronic discussions. Journal of Economic Education 2007; 38(4): 419-434.

57. Ponton MK, Carr PB, Derrick GM. A path analysis of the cognitive factors associated with Autonomous learning. International Journal of Self-Directed Learning 2004. 1(1): 59-69.

58. Star-Glass D, Military Learners: Experience in the Design and Management of Online Learning Environment, Jn of Online Learning and Teaching 2011; 7(1): 147-158.

59. Rosen, MA, Salas E, Silvestri S, Wu TS, Lazzara EH, A Measurement Tool for Simulation-Based Training in Emergency Medicine: The Simulation Module for Assessment of Resident Targeted, Simulation in Healthcare 2008; 3:170–179.

60. Briggs LJ, ed. Inter-service procedures for instructional systems development. Fort Monroe, VA: US Army Training and Doctrine Command; 1975.

61. Hannum WH, Briggs LJ. How does an instructional system design different form traditional instruction? Education Technol 1982; 9–14.

62. Gagne RM, Briggs LJ, Wager WW. Principles of instructional design. Orlando: Holt, Rinehart and Winston; 1992.

63. Bandura A. Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice Hall; 1986.

64. Jacobs LM, Burns KJ, Kaban JM, Gross RI, Cortes V, Brautigan, RT, Perdriset, GA, Besman A, Kirton O, Development and Evaluation of the Advanced Trauma, Operative Management Course, J Trauma 2003; 55:471–479.

65. Ganong W, 2003

66. Bloom B, 1956

67. Clark D. Learning Domains. Bloom's Taxonomy. (On-line). 2010; (cited 2012 Oct 28); Available at **http://www.nwlink.com/~donclark/hrd/bloom.html**, accessed 06/01/12

68. Nixon P, 1979

69. Yerkes RM, 1908
70. Sincero SM. How does Stress Affect Performance? Experiment Resources. (On-line). 2012; (cited 2012 Oct 28); Available from**:** http://www.experiment-resources.com/how-does-stress-affect-performance.html**,** accessed 06/01/12

71. Boucsein W. Electrodermal Activity. 2nd Ed., New York City: Springer. 2012.

72. Meehan M, 2002

73. Weiderhold B, Gervirtz R, Weiderhold MD. Fear of flying: A case report using virtual reality therapy with physiological monitoring. CyberPsychology and Behavior 1998, 1(2): 97-104.

74. Andreassi JL. Psychophysiology: Human behavior and physiological response, 5th ed. Mahwah, NJ: Erlbaum; 2007.

75. Guyton A, Basic characteristics of the sympathetic and parasympathetic function, Textbook of Medical Physiology, Philadelphia: W.B. Saunders Company; 1986.

76. Boucsein W, 2012

77. Meehan M, 2002

78. Weiderhold B, 1998

79. Andreassi JL. Psychophysiology: Human behavior and physiological response, 5th ed. Mahwah, NJ: Erlbaum; 2007.

80. Guyton A, 1986

81. Féré C. Note sur les modifications de la tension électrique sous l'influence des excitations sensorielles et des émotions. Comptes rendus des Séances de la Société de Biologie 1888; *5*: 217– 219.

82. Andreassi, JL, 2007

83. Boucsein W, 2012

84. Dawson ME, Schell AM, Courtney C G. The skin conductance response, anticipation, and decision-making. Journal of Neuroscience, Psychology, and Economics 2011*; 4*: 111– 116.

85. Csíkszentmihályi M. Beyond boredom and anxiety. San Francisco: Jossey-Bass Publishers. 1975.

86. Nacke LE, Drachen A, Kuikkaniemi, K, Niesenhaus J, Korhonen, H, Hoogen, W M, et al. Playability and Player Experience Research. Proceedings of DiGRA 2009: Breaking New Ground: Innovation in Games, Play, Practice and Theory, London, UK.

87. Csíkszentmihályi M, 1975

88. Byrne TJ, 2010

89. Berkenstadt H, 1999

90. Byrne TJ, 2010

91. Nacke LE, 2009

92. Wren SM, Innovative Leadership of Casualty Care. Arch Surgery 2011; 146(12):1350-1358.

93. Husum H, Gilbert M, Wisborg T. *Save Lives, Save Limbs.* Penang, Malaysia: Third World Network; 2000.

94. H, Gilbert M, Wisborg T, Van Heng Y, Murad M. Rural prehospital trauma systems improve trauma outcome in low-income countries: a prospective study from North Iraq and Cambodia. *J Trauma* 2003; 54(6):1188-1196.

95. Cook DA, 2011

96. Gaba D. The future vision of simulation in health care. Qual Saf Health Care 2004; 13(Suppl 1): i2–i10.

97. Cook DA, 2011

98. Cook DA, 2011

99. Issenberg SB, McGaghie WC, Petrusa ER, Lee Gordon D, Scalese RJ. Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. Med Teach 2005; 27:10-28.

100. McGaghie WC 2010

101. Nestle D, Groom J, Eikeland-Husebe, S O'Donnell JM. Simulation for Learning and Teaching Procedural Skills, the State of the Science, Simulation in Healthcare 2011; 6:S10-S13.

102. Lucisano KE, Talbot, LA, Simulation Training for Advanced Airway Management for Anesthesia and Other Healthcare Providers: A Systematic Review, American Association Nurse Anesthetists 2012; 80(1):25-31.

103. Issenberg SB, 2005

104. Kirkpatrick DI. Evaluating Training Programs: The Four Levels, 2nd ed. San Francisco: Berrett-Koehler; 1998.

105. Salas E, Burke CS, Bowers CA, Wilson KA. Team training in the skies: does crew resource management (CRM) training work? Hum Factors 2001; 43:641-674.

106. Cook DA, 2011

107. McGaghie WC, 2010

108. Hall RE, Plant JR, Bands CJ, Wall AR, Kang J, Hall CA. Human patient simulation is effective for teaching paramedic students endotracheal intubation. Academic Emerg Med 2005; 12(9):850–5.

109. Davis DP, Buono C, Fotd J, Paulson L, Koenig W, Carrison D. The effectiveness of a novel, algorithm-based difficult airway curriculum for air medical crews using human patient simulators. Prehosp Emerg Care 2007; 11:72-79.

110. Nishisaki A, Donoghue AJ, Colborn S, Watson C, Meyer A, Niles D, Bishnoi R, Hales R, Hutchins L, Helfaer MA, Brown CA 3rd, Walls RM, Nadkarni VM, Boulet JR, Development of an instrument for a primary airway provider's performance with an ICU multidisciplinary team in pediatric respiratory failure using simulation. Respiratory Care 2012; 57(7):1121-8.

111. Mayo PH, Hackney JE, Muick JT, Ribaudo V, Schneider RE. Achieving house staff competence in emergency airway management: results of a teaching program using a computerized patient simulator. Crit Care Med 2004; 32(12):2422-2427.

112. Abrahamson S, Denson JS, Wolf RM. Effectiveness of a simulator in training anesthesiology residents. Quality & Safety in Health Care 1969; 2004; 13(5):395-7.

113. Barsuk D, Ziv A, Lin G, Blumenfeld A, Rubin O, Keidan I, Munz Y. Berkenstadt H. Using advanced simulation for recognition and correction of gaps in airway and breathing management skills in prehospital trauma care. Anesthesia & Analgesia 2005; 100(3):803-9.

114. Batchelder AJ, Steel A, Mackenzie R, Hormis AP, Daniels TS, Holding N. Simulation as a tool to improve the safety of pre-hospital anaesthesia--a pilot study. Anaesthesia 2009; 64(9):978-83.

115. Crabtree NA, Chandra DB, Weiss ID, Joo HS, Naik VN. Fibreopitic airway training: correlation of simulator performance and clinical skill. Can J Anaeslh. 2008; 55(2):100-104.

116. Goldmann K, Steinfeldt T. Acquisition of basic fiberoptic intubation skills with a virtual reality airway simulator. J Clin Anesth 2006; 18(3):173-178.

117. Johnson KB, Syroid ND, Drews FA, Ogden LL, Strayer DL,Pace NL, Tyler DL, White JL, Westenskow DR. Part task and variable priority training in first-year anesthesia resident education: a combined didactic and simulation-based approach to improve management of adverse airway and respiratory events. Anesthesiology 2008; 108(5):831-840.

118. Olympio MA, Whelan R, Ford RP, Failure of simulation training to change residents' management of oesophageal intubation. British Journal of Anaesthesia 2003; 91(3):312-8.

119. Pott LM, Santrock D. Teacbing without a teacher: developing competence with a Bullard Laryngoscope using only a structured self-learning course and practicing on a mannequin. J Clin Anesth 2007; 19(8):583-586.

120. Rowe R, Cohen RA. An evaluation of a virtual reality airway simulator. Anesthesia & Analgesia 2002; 95(1):62-6.

121. Russo SG, Eich C, Barwing J, Nickel EA, Braun U, Graf BM. Timmermann A. Self-reported changes in attitude and behavior after attending a simulation-aided airway management course. Journal of Clinical Anesthesia 2007; 19(7):517-22.

122. Binstadt E, Donner S, Nelson J, Flottemesch T, Hegarty C. Simulator training improves fiber-optic intubation proficiency among emergency medicine residents. Academic Emergency Medicine 2008; 15(11):1211-4.

123. Kovacs G, Bullock G, Ackroyd-Stolarz S. Cain E, Pétrie D. A randomized controlled trial on the effect of educational interventions in promoting airway management skill maintenance. Ann Enwrg Med
2000; 36(4):301-309.

124. Sudikoff SN, Overly FL, Shapiro MJ. High-fidelity medical simulation as a technique to improve pediatric residents' emergency airway management and teamwork: a pilot study. Pediatric Emergency Care 2009; 25(10):651-6.

125. Chen PT, Huang YC, Cheng HW, Wang CC, Chan CY, Chan KH, Kuo CD. New simulation-based airway management training program for junior physicians: Advanced Airway Life Support. Medical Teacher 2009; 31(8):e338-44.

126. Batchelder AJ, 2009

127. Pott LM, 2007

128. Johnson KB, 2008

129. Barsuk D, 2005

130. Batchelder AJ, 2009

131. Goldmann K, 2006

132. Olympio MA, 2003

133. Russo SG, 2007

134. Davis DP, 2007

135. Batchelder AJ, 2009

136. Phaal R, 2004

137. Downing SM. Validity: on the meaningful interpretation of assessment data. Med Educ 2003; 37:830–7.

138. Messick S. Validity of psychological assessment: validation of inferences from persons' responses and performances as scientific inquiry into score meaning. Am Psychol 1995; 50:741–749.

139. American Educational Research Association, Psychological Association, & National Council on Measurement in Education. Standards for Educational and Psychological Testing. Washington, DC: American Educational Research Association; 1999.

140. Regehr G, MacRae H, Reznick RK, et al. Comparing the psychometric properties of checklists and global rating scales for assessing performance on an OSCE-format examination. Acad Med 1998; 73:993.

141. Martin JA, Regehr G, Reznick R, et al. Objective structured assessment of technical skill (OSATS) for surgical residents. Br J Surg 1997; 84:273.

142. Fried GM, Feldman LS. Objective assessment of technical performance. World J Surg 2008; 32:156.

143. Mayo PH, 2004

144. Savel RH, Goldstein EB, Gropper MA. Critical care checklists, the Keystone Project, and the Office for Human Research protections: a case for streamlining the approval process in quality improvement research. Crit Care Med 2009; 37(2):725-728.

145. Reported in MU Combat Casualty Training Consortium, 2nd Quarterly report FY13, IVIR, Mar 13, 2013

146. Reported in MU Combat Casualty Training Consortium, 2nd Quarterly report FY13, IVIR, Mar 13, 2013

VITA

Christina L. Stephan was born in Houston Texas in 1963. She completed her undergraduate work in 1983 at Texas A&M University. The first seven years of her career involved large scale system integration and network design. In 1994 Christina completed her MBA while working full time for the Department of Army as a Network Consultant. This was followed by medical school and residency training in Pathology. Building on her prior experience, Christina began working as a post-doctoral Fellow in the National Library of Medicine Fellowship in Health Informatics. This was followed by work as Senior Policy Research Analyst, completion of MPH and PhD in Health Informatics. Christina has been happily married for 23 years and has three beautiful adult children.