Research Proposal

By

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Research Elective

Critical Choices for Combat Medics, Training in Virtual/Augmented Reality

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Disclaimer

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Biography

Major David Morgan is assigned to 94^{th} Aeronautical Staging and Transport Squadron (ASTS), Dobbins Air Reserve Base, Georgia as a traditional Air Force Reserve member. In his current position as a Critical Care Air Transport Team (CCATT) Coordinator, Major Morgan is responsible for two CCATT teams, each consisting of a physician, registered nurse and respiratory therapist. The purpose of the CCATT team is to provide critical care to wounded personnel to higher levels of care in the back of aircraft. Major Morgan previously served as the Officer in Charge for Education and Training for the 94^{th} ASTS. During this time Major Morgan was the Self-Aid Buddy Care Wing Advisor for the 94^{th} Air Wing and assisted in the instruction for multiple Emergency Medical Technician review classes.

Major Morgan's civilian career he drove an ambulance for 10 years prior to starting his nursing career in 1997. He worked as a registered nurse in a Level One trauma center in the Surgical Intensive Care Unit, Post Anesthesia Care Unit and instructed Basic Life Support, Basic Disaster Life Support and Advance Disaster Life Support. He is currently working in an urgent care center as a Family Nurse Practitioner.

Abstract

The Combat Action Tourniquet is a life saving device that is applied to the limbs for serious bodily injuries that may cause exsanguination. It is extremely important to have proper placement along with correct application to stop the flow of blood distal (down) from the tourniquet application site. There have been times where the tourniquet has not been applied correctly and patients bleed to death. The use of virtual reality or augmented reality can assist the combat medics retain the training they received prior to deployments.

Research Proposal

Thesis Statement: Can virtual reality/augmented reality (VR/AR) increase the retention of learned skills for combat medics related to appropriate placement of the Combat Action Tourniquets (CAT)?

Background

Current Air Force Air Expeditionary Force (AEF) deployment cycles ranges from 20 months to 24 months at home base prior to potential deployment.[1] Each unit will not usually deploy during their deployment cycle and may have to wait until the next deployment vulnerability cycle to deploy. In prior years, Army units may average a 12-month deployment followed by 24 months at home station.[2] and Marine units will normally have a 12-month home time for every 6 months deployed.[3] The Marines utilize Navy Corpsmen to provide combat care to their Marines.

Combat medics are used to provide lifesaving battlefield triage and care to troops during enemy engagements. When a service member is injured, there is a variety of distractions the medic must take into consideration when first approaching their patient. The enemy may still be engaged and taking fire. This may overwhelm the senses of sight, smell, sound and vibration of the medic as they are delivering care. This triage and care must be done rapidly to provide potential lifesaving actions during care-under-fire. To complicate matters, the Air Force is changing from the Individual First Aid Kit (IFAK) to the Joint First Aid Kit (JFAK). This will change the location of items within the kit which will need additional familiarization of equipment prior to deployments. Concentration and correct use of the medic's kit is imperative for the injured service member. Skills used on the battle field are of high importance and, unless you are deployed to a combat zone, rarely used. To prevent possible exsanguination from wounds that occur on arms or legs, combat medics utilize the Combat Action Tourniquet (CAT). The CAT is utilized to stem the flow of blood and prevent major blood loss and shock. Having proper placement of the CAT is extremely important to save the injured servicemembers life. During home station times, medics usually have responsibilities in the hospital or care center, taking care of the same service members while in garrison. The use of the CAT while in garrison is virtually zero, apart from rare injuries during training. Combat medics are expected to be able to recall how properly place the CAT in injured servicemen at any moment with little continual training.

Learning Theory

According to Hale and Stanney, it is discussed that the human to machine interface in the virtual world should be as rich in information to the eyes as the real world.[4] The goal is to create virtual immersion or presence. Presence is achieved when the participant reacts to stimulus as they would in the real world. Virtual immersion is where the participant has difficulty with separating themselves from the game and the real world. With full virtual immersion, the perception of what is real is difficult to discern because you mind thinks it is happening. Dang et al. discussed the difference in using three different areas for presence in simulation. They were using either in-person, VR or watching recordings on television of clinical scenarios to see how the subjects felt afterwards.[5] Dang et al. questioned the degree of immersion within those specific testing areas. During the experiment, a clinical issue arose where students were able to be active live participants, watch the entire simulation on a VR headset or watch only on a TV screen.

Dang et al. discovered that in person training did provide the most presence feeling followed by VR experience and lastly the TV sessions. It was discussed that mobile VR could be an untapped resource in the simulation field as actual clinical exposure is being transferred to simulation.[6]

As combining VR/AR with hands-on simulation, this could only increase the sense of presence and transfer of tactile knowledge. With increased hands-on experience that is combined with auditory and visual distractions may further the sense of presence for the combat medic. Current training such as Self-Aid Buddy Care (SABC), online portions only show videos of the content. Some hands on is required but the amount of is a minimal.

Six degrees of freedom within the virtual world will allow the medics to move in three axis of rotation. As compared to aircraft, this would be roll, pitch and yaw movements.[7] Medics would have the ability to reach, turn and move within the program to gain a better simulation instead of a Power Point presentation. Access to the six-degrees of freedom, the medic could interact with a variety of simulations within the VR world. With the addition full auditory stimulus, this will influence the total immersion, especially if the auditory stimulus can be represented in different areas. The use of tactile stimulation while using haptics can assist the user manipulate objects and interact with items around them.

Cognitive Learning Theory

Tenison, Caitlin, Fincham and Anderson discussed the three phases of the cognitive learning, encoding, solving and responding.[8] In their study, participants performance with problem solving activities tend to speed up as a power function as related to the amount of practice on the problem. The authors mapped pathways within the brain as subjects completed math problems while under and MRI. It was noted during the study that times used for encoding problems that were seen prior had decreased in time and the subjects moved to solving and responding in a faster manner. This study described practice will assist the subjects to reduce the response time of problem solving. It is hypothesized that continued practice with tasks will also decrease the response time as other subjects are introduced to the learning and practice. Tenison, Caitlin, Fincham and Anderson also described that the variability of the answers decreased with practice. The authors found the time the subjects took to complete problems decreased from 12 seconds to 3 seconds, with 36 opportunities to practice.[9]

Peterson, Furuichi and Ferris utilized VR with subjects to simulate walking at heights across a small beam. This simulation which was done first without VR as the participant walked across the room. The second simulation was at a low height VR, while the third simulation was at a height of 15 meters in VR. Their hypothesis was to see if the VR at the highest setting would induce a physiologic stress response which would reduce their cognitive performance.[10] Stress responses were measured with sensors that monitored heart rates, brain wave patterns and with written responses from subjects. It was shown that the participant's heart rates did increase with the high VR testing as well as the amount of time it took to completed the simulation as compared from the low height simulation and the trial without VR.[11]

Although this study was focused on balance, an increase in cognitive loading can be used in other research as well. A direct correlation can be inferred with battlefield simulations for medical personnel. With chaos of battle, the amount of auditory stimulus could be overwhelming. When combat medics come upon a patient, having to concentrate in this chaotic environment is paramount for quality patient outcomes. With VR in the simulated combat zone, medical personnel will have the same distractions of sound, visual and tactile feedback they may have with live fire. Sui, et al. also described how consistent use of VR decreased response times within the VR system.[12] By looking at both sets of research, the goal would be to allow medical personnel to experience this stress which could decrease the cognitive load and decrease their response times. Sui et al., discussed the use of virtual reality to increase he skill of surgeons within the armed forces as skills may differ from battlefield to civilian practice.[13] While deployed to the battlefield, surgeons may lose or have deteriorated skills that are necessary for quality surgical procedures. When returning to their non-combat practice, there is a learning curve that the surgeons go through to bring back the lost skills. This could affect the quality of surgical practice and may increase mortality and morbidity rates.[14]

Sui et al.'s research described how virtual reality (VR) can be used to reduce the retraining time for the surgeons to maintain their skill levels. They discuss how the simulation training can be used to assist in the cognitive training aspect in frequent repetitive tasks. It is also discussed how the decay of surgical skills can be decreased through the use of VR. Using the VR system, tasks were measured by time with multiple attempts. Subsequent tasks took less time, theorizing this will decrease skill loss.[15]

While this Sui et al.'s study uses learning in VR to stop the decay of skills for returning surgeons, it can also be theorized that skills for troops going into combat can be enhanced through VR. Medical skills that are used on the battlefield would be decayed while troops are in garrison. The use of VR will assist in keeping skills honed and give the ability for medics to respond rapidly to emergent situations. Building on Hale and Stanney, having total immersion of the VR training would assist in medic training and reduce mortality with simulated combat injuries on the battlefield.

Stanković, Maksimović, and Osmanović are familiar with the management of instruction for classrooms working in the Department of Pedagogy. The authors discuss using teaching techniques and content to maximize the learning process.[16] Stanković, Maksimović, and Osmanović discussed that Piaget's theory of cognitive learning uses assimilation and accommodation in the learning process.[17] With the development of the *Cognitive theory of multimedia learning,* it is discussed using the three memory functions. Those functions are sensory memory, working memory and long-term memory. Also, discussed in the learning process is how verbal, visual and manipulative-motor learning has increased the level of learning in a positive manner.[18]

Stanković, Maksimović, and Osmanović described how using multimedia use can facilitate learning. It is also discussed that multimedia blended into the learning process can create new learning process that can be brought into the classroom.[19]

With the adaptation of VR into the current military system, bringing the cognitive learning style with visual, auditory and tactile stimulation will increase long term memory. This builds upon the research of Sui, et al. with the reduction of skill loss from lack of activities.[20] With combat medics fully immersed into a training scenario that stimulates hearing, visual and tactile stimulus as described by Hale and Stanney, programmers can increase the simulation activate the three memory functions and make appropriate programing choices to promote long term memory.

Novice to Expert

Patricia Benner's theory of Novice to Expert in nursing can be extrapolated to combat medics. Benner's theory discussed that experienced clinicians (medics) gain knowledge and master competencies that are not taught in a classroom. Benner theorized that there are five stages in competency. Those are novice, advanced beginner, competence, proficient and expert.[21] As one is learning a new skill, such as the application of the CAT, it is expected that the combat medics master the skill in a short amount of time.

The novice has the basic classroom skills for tasks and has no real experience in the task.[22] The advance beginners stage begins after the novice has considerable experience with the task. Competence comes when the advance beginner has the ability to make new rules for the experiences because of the changing complexity of tasks.[23] The competent medic knows that all the situations they were taught may not be inclusive of the scenarios they may find themselves in on the battlefield. Proficient medical personnel have a wealth of experiences to call upon for tasks that the medics have done before and will become a more situational response. Benner state that proficient members, "intuitive behavior replaced reasoned responses".[24] Experts have grown their proficiency to a higher level that they can distinguish instances that may be similar to others but quickly choose the correct action.[25]

Larew et al. used Benner's theory in a study using simulation for students. It was discussed that competency requires practice in the clinical environment. The clinical environment for combat medics is the battlefield. Having a standardized VR/AR environment, will allow the experiences needed to meet the desired objectives. Having the VR/AR environment may also allow the recording of the simulation and allow visual and auditory feedback to the participant to increase the medic's confidence and correct placement of the CAT. As the medic is getting this feedback, Larew et al. discussed that simulation is a safe way for clinicians to gain experience that students can consistently meet training objectives.[26]

Griswold-Theodorson et al. reviewed clinical research and discussed clinical training with physician students and Residents and how this simulation of training is reaching the bedside of the patients. When clinicians are trained, it is paramount that this training is applicable to the patient and can be consistently be reproducible. It was discussed how the simulation-based model, using the Dreyfus/Benner learning model has discrete steps. "typically includes development of foundational knowledge, integration of pieces of information, application of information into problem solving, and transfer of information to different contexts".[27] The authors suggested that the trainees would have a "better working knowledge of practice areas, become more autonomous, may require less supervision, and are able to complete more complex tasks using their own judgment".[28]

Training in VR/AR

Utilizing VR for training will allow the medics to gain training immersion utilizing hands on use with virtual patients that have life threating injuries. With VR/AR, programmers can simulate full acoustical immersion within the battlefield (program) and allow the medics to use their skills with the distractions, such as weapons firing, screaming and ordinance explosions that may occur. While delivering care to their patient the medic must keep their concentration on the patient when rendering care. It will help focus those in training and create muscle memory when reaching for items in kits that have changed and give more confidence to our medics.

Kragh et al. discussed the use of tourniquets as related to battlefield survival rates with the application of emergency tourniquets to control bleeding in limb injury. The authors reviewed patients that were coming into a military hospital during the Iraq war. They reviewed 499 patients representing 14 countries of varied ages.[29] Of those patients, there were 862 combat tourniquets applied for the use to control bleeding. It was discovered that 445 tourniquets were applied once to a limb. If a patient did not have hemostasis (control of bleeding) with one tourniquet application, a second or more was added to control bleeding.

If combat medics do not place the tourniquets properly, additional training needs to be completed to allow proper placement and "tightness" of the tourniquet. Here VR/AR could be used to allow the medics to get the proper training prior to deployment as well as continuing training to maintain those critical skills. Having the ability to get proper placement with adequate pressure could be done in the VR/AR environment without having to use live persons in placing the device. As described by Tenison et al., the more practice a person had with practice placing tourniquets, the amount of time is taking for placement decreased.[30]

Failure rates for the application of CATs during the combat operations in Afghanistan that presented to one field surgical team was 76% because they were not applied correctly and were there should not be a pulse, the surgical team did detect a pulse that was distal to the CAT placement.[31] Application of the CAT during hostile engagements can be reduced to 0 percent as demonstrated the Israeli Defense Force. Baruch et al. studied the Israeli Defense Force (IDF) troops that are new to the military.[32] The purpose of this study was to determine if practice after the initial Israeli "Life Saver" course in the placement of tourniquets would improve in timing, efficiency and the quality placement of the device. Troops were divided into two groups which decided ho may practice times per month they were allowed to use the tourniquet. They were then evaluated 14 days after the first training for the initial documentation and at a three-month interval the second assessment was completed.

It was shown that the group that was able to practice more with the tourniquets had a higher improvement with application over those that were able to practice one time per month. The study also showed those that practiced on humans in the beginning had an unintended cross benefit to the model because the model was able to watch the participant place the tourniquet and would learn from mistakes.[33]

This is important to this research because Baruch et al. showed continued exposure to practice with tourniquets, the response time for placement decreased while the amount of pressure applied with the tourniquet to stop blood flow increased.[34] The mannequins utilized simulated blood flow and could determine if adequate pressure was used. This testing was limited to one person at a time and there was an instructor needed to be close for observation. With VR/AR, there can be multiple subjects practicing at the same time with could be recorded for observational feedback. Members could also practice on their own without instructors present to become more proficient at placing the tourniquets. Continual training is needed to increase muscle memory and allow proper placement of the CAT during combat operations.

Data collected by King et al. described patients that were sent to a forward surgical team (FST) in Afghanistan during Operation ENDURING FREEDOM. The authors reviewed the types of injuries, bleeding control and presence of a pulse that was distal to the tourniquet placement.[35] Tourniquets were that were placed on 79 injured service members were reviewed. The placement of the devices was completed by combat medics, special operations medics, flight medics and surgeons. There were four different styles that were noted, the Combat Action Tourniquet (CAT), Special Operation Forces Tactical Tourniquet (SOFT-T), ratchet style tourniquets and improvised tourniquets. Of those placements, reviewing for arterial and venous injuries, pulse checks distal to injury and revascularization was completed. It was discovered that 64 % of the tourniquets that were applied to arterial injuries were not adequately applied. When the person that applied the tourniquet was given feedback on the application of the tourniquet it was noted that "All medics were surprised as to how tight a tourniquet must be to stop arterial flow".[36] This feedback from the front-line medics shows that the training that is received is inadequate for the battle field.

Schreckengaust et al. discussed using the Combat Application Tourniquet (CAT) and the Special Operations Forces Tactical Tourniquet (SOFT-T) in simulated combat training to judge the effectiveness of tourniquet placement during combat. It was noted in the research that between 2001 and 2011, 91% of potentially survivable battlefield injuries were due to hemorrhage.[37] Schreckengaust et al. showed that tourniquet applications in non-combat related situations had a decreased failure rate as compared to those placed during combat operations. They suggested the difference in failure rates could be attributed to combat stress on the medic during CAT application. There were 89 Hospital Corpsman that took part in this study that measure the time of application of the tourniquet and adequate pressure to control the pulse of the subject, distally from the application. It was shown that the speed did decease in application of the tourniquets while in classroom settings. During simulated combat applications, there was an increase in time of application of almost 50%, from 38 seconds to 57 seconds. There was also a decrease in the pulse elimination rate from 73% to 67%; which, the authors thought was insignificant.[38]

Butt, Kardong-Edgren and Ellertson discussed how using virtual reality (VR) in the nursing core field to have student nurses practice to acquire new skill and increase the comfort levels of performing those skills.[39] In current practice, nursing students are shown a skill and have limited opportunities to practice the skill before they are called to perform the skill on active patients. This does not allow the student enough time to become proficient at the skill and develop a comfort level in skill completion.[38] Butt, Kardong-Edgren and Ellertson discussed that having a VR practice area, students can individually practice certain skills and get immediate feedback. Having this immediate feedback can help the student in correct procedure application instead of having mistaken procedural steps take hold in the learning environment. "Deliberate practice" is needed to have the student enhance their procedural skills and increase the retention rate of those skills.[40]

Students utilized a VR program that would monitor their progress and sterile technique in placement of urinary catheters. Students utilized the Oculus Rift and haptic gloves for sensory input. Butt, Kardong-Edgren and Ellertson concluded that the return on investment of the system and programing could increase the skill retention of nursing students and improve patient care outcomes.[41] They also discussed how it is the responsibility of the students to transfer the skills and learning adopted during the training to actual patient care. [38] Butt, Kardong-Edgren and Ellertson suggested that utilizing a VR system in teaching can help fill the gap in skill development and retention of students.

Methodology of Training

It was discussed that all service members get training in the use of tourniquets prior to deployments. Care under fire (tactical care) is used to stop limb bleeding quickly to maintain hemodynamics and prevent shock. It was discussed that the best opportunity to place a tourniquet is prior to shock onset.

While training is completed with Tactical Combat Casualty Care (TCCC) course prior to standard deployments, the potential for rapid deployments and the possibility of needing quick reaction forces, constant refreshers to the course should be completed. While sending combat medics to courses that are possibly held outside the geographic area of the unit increase the cost of training, decrease training time of the individual due to travel and decreases home time prior to deployment. Having the ability to use virtual reality/augmented reality to can keep skills honed at the home unit.

Harrington et al. researched using virtual reality hardware that is a head mounted device (HMD) that was powered with the Oculus software and a touchpad that allowed users to interact with program.[42] Case scenarios were developed with input from Advanced Trauma Life Support (ATLS) instructors that mimic standard ATLS course objectives. Allowing students to work within the VR system, they were graded on diagnosis and treatment options they chose during simulation. This simulation, as stated in the research, did confirm the difference in the decision-making skills between the different expertise levels of participants as instructors score higher skill level scores as compared to residents taking the course for the first time.[43] Participants described their views after using the simulation as "extremely positive" with the virtual immersion of the program with when the outside stimulus removed with the use of the HMD. Hale and Stanney's goal to increase virtual immersion confirms the Harrington's immersion techniques by increasing the experience to those in the simulation.[44] Participants within this simulation thought that adding the VR experience could assist in the maintenance of trauma skills. With this addition of VR experiences, the immersion of trauma patients would only increase the skills of the participants with treatment options without needing real life patients.

As the skill levels increase, keeping those skills honed can be accomplished within the VR system, creating a more confident provider to deliver the trauma care that is needed in chaotic conditions. Shin's study was to immerse subjects within a VR system to see if they would have a sense of "presence" within the VR world and would they have empathetic feelings for the characters. She described VR as a storytelling medium that allows the participants to immerse themselves within the story and sometimes participate within the storyline.[45] Shin was attempting to determine how the perception of the moral values of the participants through immersion.

Shin describes a theory of empathy in VR as to have the participant feel and ‘embodiment’ within the story.[46] She also described the use of avatars and how their use will increase the participants presence in the story because they view the avatar as their own body. Shin continues stating that the participant may have stronger emotional reactions by being close to the story subject in VR as opposed to another medium. Shin hypothesized that a having a feeling of presence will have an increased effect on empathy within the VR story.[47] Her research did show that immersive stories do promote presence within the VR world. With presence, utilizing a high-fidelity recreation of a war time battle will enable the combat medic to fully engage with the training. Allowing full presence with simulation of a battlefield, the combat medic will have the all of the distractions during the time when the placement of the tourniquets are most critical. This could be the difference between proper placement and not, which could be the difference between life and death. Constructive feedback would allow the medics to learn and continue to progress along the learning path as described by Benner.

Yoon, Yun and Hyunjoo researched how the sense of presence is important in VR because the player will become more involved with the story line or program.[48] Yoon et al. described how little research has been completed regarding how users cognitively process the aspects of VR. Their study was to determine the amount of presence felt in the interactions in the VR environment. Yoon, Yun and Hyunjoo in their literature research, uncovered positive correlations between the sense of presence and the absorption within the VR platform.[49] This describes how more involved a user in a simulation the more sense of presence they will feel.

Specifically, the authors attempt to decipher the differences in females and males in the processing visual information in the VR space.

Yoon et al. discovered that females, in the VR system, as compared to males "tend to have a better sense of perceiving whole imagery and vividness of color, shape, texture or other aspects of objects. They surmise that with the differences in the processing the visual imagery of the system and the with the user's perceptions, programmers should take this into account when developing the VR environment.[50] Combat medics are not only men, all services have male and female medics. To create a high sense of presence for all medics to become fully engaged in the scenario, high graphics should be implemented to allow all participants to fell a full sense of presence. With the theory of using a high-fidelity VR system to train medics, the full sense of presence may be obtained for both sexes. With the building of the simulation, making sure that feedback is obtained feedback is obtained from both sexes is paramount.

On the battlefield, medics may have the sense of apprehension and fear with the amount of visual, auditory and tactile input that is associated during battle. Peperkorn, Diemer and Mühlberger studied how utilizing Virtual Reality (VR) to compare the relation of presence in VR with the patient's fear of spiders. This study discussed how VR could have the study subject exhibit real emotions when engaged in the VR world.[51] The authors were attempting to correlate if fear in the VR environment caused by the feeling of presence could be controlled or manipulated.

Participants were placed on electrophysiological monitors to evaluate heart rate and electrodermal monitors for monitoring skin conductivity due to stress. They were then given instructions on how to move within the VR environment. A large spider was placed virtually and was designed to be moved closer to the participant by the participant to determine when the participant would become so fearful as to stop the experiment. With concurrent exposure, the amount of time within the world increased and the spider was allowed to get closer. Physiological responses decreased from initial to subsequent exposure. This study concluded that there was a strong correlation between presence and fear in the simulation.[52] With the development of the program for combat medics, realistic training is important to provide the sense of presence of the participants. With presence in the virtual world, the concept to practice with all the distractions and "fog of war" would allow the experience to translate to the battlefield. Having combat medics that were exposed to the intensity of combat would decrease the distractions as they are providing medical care to the wounded.

Proposal for Training:

To get maximum benefit from the software that is driving the VR/AR simulation, participants should be immersed in the simulation for a small length of time to allow the participant to feel as they are a part of the simulation prior to the actual combat simulation. Allowing this would give the participants time to feel at home while in training. The simulation should use visual, sound and vibration feedback to give a sense of realism. As described by Harrington et al. the use of a HMD will be used for the visual stimulus to immerse the participant in the VR world.

Headset speakers with the capability to allow sounds from different directions is a must to immerse the participant with audio. This distraction of multiple auditory inputs within the simulation can distract the medic from their placement of the CAT. Competing auditory inputs from the battlefield should desensitize the participant and allow the medic to create coping mechanisms for full concentration on their patient.

Kim, Jeon, and Kim discussed how the lack of feedback haptics can create a missing link in the real world and the VR/AR world. With the goal of full immersion, this gap would need to be identified and filled prior to training.[53] It was described that the hand is the most used item in both the real and virtual world, so sensors with feedback is important to build the immersive world. In their study, Kim, Jeon, and Kim used only a two-finger feedback system on each hand[54] but having all fingers represented would present the best outcome for the simulation. The manipulation of the virtual CAT needs to be as realistic as possible for accurate transfer to the real world.

The first goal of the simulation is to have the medic assess the patient and decide that a CAT would need to be applied. Timing of the simulation can start at the first call out of the injured member. This would simulate the timing from injury to correct placement of the CAT and the patient can respond appropriately for decreased blood volume if the medic takes too much time. Cardiac output, the amount of blood the heart pumps in one minute, can is roughly based on the stroke volume (about 70 ml) multiplied by the heart rate.[55] The more the heart races, the quicker someone can reduce their blood volume to dangerous levels. Dependent on the injury site, blood loss can be estimated in the program as based in time until either control of the hemorrhage or exsanguination occurs. Since there will not be measurements on a live injured member at this time, the software would need to be programmed with an average leg circumference, so the proper pressure of the CAT can be calculated. Tuncali, Hakan, Zeynep and Arac discussed the formula that is used in operating rooms for knee replacement surgery. This formula takes into consideration a person's systolic blood pressure and the padding coefficient (leg diameter) to determine the amount of pressure needed to stop eliminate bleeding during surgery.[56] During stressful situations, blood pressure tends to elevate and with combat gear, proper leg sizes maybe difficult to estimate quickly. Wall et al. found the standard three turns of the windlass on the CAT did not achieve a stoppage in blood flow in some instances.[57] This is why continued training is important. The simulation can be adjusted to allow participating to experience different types of simulation for hemorrhage control.

Participants would be divided into two group. Group One will have standard training six months prior to deployment. Group One will then be asked to perform the training they received one month prior to deployment. Group Two will undergo the same training as group one and a VR/AR based simulation will be added to the training cycle. This system will also be available for continual training up to the deployment with a minimum of one time per week simulation exposure.

Expected Outcome:

One month prior to deployment, participants will have an evaluation for the proper placement of the CAT. This evaluation would include the timing to application of the CAT and the absence of a pulse. Absence of pulse can be determined by using a doppler device to verify the absence of a pulse distal to the CAT placement on a live model. It is expected that Group Two will have faster times to CAT application with less failure rates than Group One. Additional practice and involvement within the simulation, Group Two should have the expected focus for concentration and cognitively reduce the amount of distractions they process and allow them to increase their concentration of caring for their patient.

In order to keep troops safe and provide optimal care on the battlefield, Group One will be allowed an additional 30 days of free use of the software prior to deployment. This remedial training will not change the deployment cycle of those in Group One but completing the simulation training will increase their confidence and abilities prior to deployment to the combat area.

Allowing the participants to rate their experience and confidence levels on a standard 1-5 selection guide can give feedback to the staff. The grading would extremely disagree, disagree, neither agree or disagree, agree and extremely agree. Additional questions may be added to derive feedback to increase the realism, training timeframe, scenario changes and an open-ended question where participants can express future wants and desires in the training regimen.

Conclusion

Proper placement of Combat Action Tourniquets will save lives when properly placed and with enough pressure to stop the flow of blood distal to the tourniquet placement. Research showed there is room for improvement and also showed that the error rate can reach zero. Continued practice that involves VR/AR can assist the combat medics in retention of skills that are taught in the Combat Casualty Care Course and Self Aid Buddy Care courses. Those courses are completed prior to deployments and with continued practice in the VR/AR scenarios, combat medics will be able to decrease the skill lost because of lack of use of the tourniquets. Utilizing both the cognitive learning theory and Benner's theory from novice to expert, continued practice should allow the combat medic to retain their training. This continued practice will move the combat medic along the spectrum to become an expert in proper placement and use of the tourniquet and decrease CAT placement failures.

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