Detecting Hesitation during Battlefield Wound Treatment on Female Soldiers

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Abstract. Trauma care training using a female gender retrofit kit (GRK) may provide for a more realistic environment to decrease any training gaps associated with providing trauma care to men and women. This paper builds upon pilot research [1] indicating participants hesitate when assessing a gunshot wound on a simulated female casualty compared to the same wound on a male casualty and make more errors in placing chest seals on female casualties. Using a 2 (gender of participant) x 2 (gender of the manikin) mixed design, participants must assess and treat two gunshot wounds on each manikin. The dependent measures include initial response time, exposure time, time on task, total task time, exposure success, and accuracy of the chest seals. This experiment identified that participants are more likely to miss gunshot wounds on the female casualty if covered by a bra, and struggle to apply the chest seals appropriately.

Keywords: Human Factors · Gender Retrofit Kit · Trauma Training

1 Introduction

The opportunities for women in the military are constantly increasing as noted in 2016 with the allowance of women in combat arms duty positions. According to the Department of Defense's Manpower Requirement Report of the 2020 fiscal year, women soldiers represent 14.9% of the Army's Active Duty force [1]. While women have been added to the combat arms branches, medical training does not yet reflect gender integration, leading to possible training gaps in female soldier trauma care. To adjust for the influx of women entering the military, medical training needs to incorporate scenarios of treating women in combat to create competency. A possible limitation of current training is soldiers training to perform Tactical Combat Casualty Care (TC3) only on male manikins instead of a combination of both male and female. In both Operations Enduring Freedom and Iraqi Freedom, women had a lower survivability rate by 18.9% in OEF and 2.5% in OIF with a significant amount of these injuries in the upper torso, thus requiring further analysis of why women have these lower rates of survival [2]. Female trauma care is important because soldiers will fight how they train; if soldiers do not train to treat female soldiers, then a female's life is at risk if they sustain a wound in combat. Soldiers cannot expect to perform flawlessly with-

out proper training. In the realm of trauma training, hesitation could lead to the loss of a life.

Females should have an advantage in the combat trauma world, as having greater levels of estrogen naturally helps the body with recovery. Females under the age of 50 and premenopausal tend to have lower rates of developing sepsis, a lower rate of Multiple Organ Dysfunction Syndrome (MODS), and lower plasma cytokine levels. One can conclude that females who are premenopausal recover better from severe injuries because of their immune system [3]. The higher level of estrogen also leads to lower levels of lactate which allows the body to send oxygen and blood to the rest of the body instead of going into shock [4]. Although women have a hormonal advantage in recovery from injuries compared to men, these findings do not translate to the battlefield. The military handles casualties differently than the civilian world because the injuries are much different, and roughly 87% of the casualty deaths happen before reaching a medical tent [5].

A possible reason why this advantage does not translate into the military is the lack of training on female medical manikins. Working on a female manikin allows for more realistic anatomical training; however, the military has not implemented realistic female manikins in the Army's trauma training program. This can lead to hesitation when treating female casualties on the battlefield, in turn negating their hormonal advantage and increasing their chances of death. For example, Schauer and colleagues [6] concluded that females suffered more severe injuries and had a lower tourniquet application rate out of all the prehospital interventions compared to men, further supporting the reasoning for future research. The areas where tourniquets and chest seals need to be applied are also areas that can make individuals uncomfortable by cutting pants and exposing their thighs, and hesitant if they are not competent in the proper steps for care. Lack of training on anatomical models leads to hesitation and lack of consistent training [7]. One potential solution to decreasing the hesitation in trauma care on females could be the use of the GRK as it provides a more realistic simulation. Using the GRK can help soldiers become more competent and less hesitant when treating a female with a gunshot wound in the chest area [7].

1.1 Research Question & Hypothesis

The objective for the current research project is to explore if there are any gaps that exist in current trauma care training. Specifically, our research question is whether there is an effect on accuracy and time with treating female casualties in a point of injury trauma training scenario. This study aims to determine where the training gap lies in trauma training, and how to reduce that gap with manikin simulations. It will determine whether hesitation of soldiers will increase, potentially affecting performance, since every second wasted by waiting is a second lost in trying to save lives. Overall, the Army must continually evaluate their medical training to understand where gaps may exist to ensure the safety of their soldiers. Some motivation for this study based on another experiment [8] is to measure a larger sample size, with both male and female participants, while paying attention to the hesitation of participants, accuracy of finding the gunshot wounds, and the placement of the chest seals. Different from previous studies [8,9], this experiment uses an updated version of the GRK that more accurately simulates female anatomy. Based on previous experiments [10]

our first hypothesis is both male and female participants will have a larger mean exposure time on the manikin wearing the female retrofit kit because of the inexperience with female manikins. Our second hypothesis is with the lack of training on female manikins, the accuracy of the chest seal placement on the manikin on the female retrofit kit will be lower than on the male manikin.

2 Methods

2.1 Participants

The participants in this study consisted of both female and male cadets at the United States Military Academy who are all above the age of 18. The goal number of participants is 40 to ensure there are enough to counterbalance the order in which participants assess the different gendered manikins. Each participant was a student in the mandatory general psychology for leaders (PL100) or psychology for leaders (PL300), and they received extra credit towards the course through SONA. Each participant had a basic understanding of Tactical Combat Casualty Care (TC3) as they learned it during Cadet Basic Training and became certified as a Combat Life Saver. Some of the participants in PL300 have more medical training as they are in their third or fourth year at West Point and have more practice with TC3.

2.2 Materials

For the duration of the experiment, there will be two different manikins in use: a standard Laerdal patient simulator manikin (female), and a CAE iStan manikin (male). The Laerdal manikin will be wearing the most updated Gender Retrofit Kit and facemask, thus making the manikin resemble a female. To produce gunshot wounds that the participant will have to treat, a trauma tattoo (Figure 1) is applied using water and paper towels and finished off with two sprays of synthetic blood from a spray bottle. In light of the current pandemic and the need to be extra cautious, the manikins are dressed in the hot weather OCPs (top, bottom, and t-shirt) and each one has another pair of OCPS to switch out between participants to protect them from contracting COVID-19. The manikin with the GRK will wear a new black disposable bra for each participant as seen in Figure 1. The participant must cut the disposable bra to treat the casualty. Each clothing item will have cuts where the gunshot wound is to simulate a real gunshot wound. Each manikin will have two gunshot wounds on the front with no exiting wounds. The experimenter will place one of the trauma tattoos five inches above the causality's right nipple and two inches toward the center line of the ribcage. The second tattoo is placed two inches above the casualty's left nipple and two and a half inches towards the casualty's left axilla. Placing the tattoo requires a damp paper towel to apply pressure for thirty seconds onto the tattoo to set onto the manikin's skin. To finish off the wounds, two sprays of blood (see below) will go on each tattoo, and the experimenter will apply one spray to each article of clothing where the wound is.

Fig. 1. On the left is the male manikin with the two trauma tattoos applied and in the middle and on the right is the manikin wearing the GRK with the disposable bra on and the trauma tattoos applied.

A stopwatch will be used to time the participant in each stage of assessing and treating the casualty. The stopwatch utilized in this experiment is the stopwatch on the iPhone X, as this watch displays each lap with the time (in seconds) since the last lap.

Treatment Materials

Three Hyfin® chest seals are laid next to the manikin's head for easy reach for whatever side the participant is treating, plus an extra one in case of errors. The chest seal package comes with a wipe to clean up the dirt and blood that may be there and then a chest seal to prevent any more air leaving the lung through the wound. Next to the chest seals with the female is also a pair of scissors that the participant may use if they wish to only cut the bra off to expose the casualty.

COVID-19 Cleaning Supplies

The COVID-19 materials consist of Kleenguard G10 Nitrile gloves for the participants to wear throughout the entire experiment. There will be Physicians care Alcohol Pads to clean up the blood from the spray bottle, disinfect the manikins and any surface the participant touched in order to prevent spreading of any germs.

Questionnaire

Before the participant begins assessing the manikins, he or she will read the briefing form and fill out a demographic questionnaire. After each assessment of the manikin, the participants will fill out a paper copy of the post-assessment survey for each manikin. The post-assessment survey consists of 4 questions and a free response question regarding the manikin they just assessed and treated. The Likert scale is a 5-point scale ranging from 1= strongly disagree to 5= strongly agree. The survey assesses the participant's personal belief in their ability to assess and treat, their comfort level in TC3, and confidence level in applying a chest seal to a patient with a gunshot wound. The last question asks how they believe the Army does or does not adequately prepare

them to assess and treat either male or female soldiers. The free response question allows participants to explain why they do or do not feel comfortable applying a chest seal to a male or female. Each survey is gender specific to understand how the participants feel towards men and women with TC3.

2.3 Procedure

The first block of the exam consists of welcoming and briefing the participant on the upcoming tasks they must complete. To ensure the safety of all the participants, each one is asked the three West Point COVID questions to ensure they do not have COVID. Before the participant begins assessing the casualties, they read the briefing form to understand what they are agreeing to participate in, and then complete a demographic questionnaire. After the forms are filled out the individuals will watch a 3-minute instructional video on the proper procedure of applying chest seals to a sucking chest wound from a gunshot [11]. This video provides an opportunity for the participants to refresh their memory and knowledge of how to perform such tasks, since it has likely been a couple months since they have applied a chest seal. There is an opportunity after watching the video for the participants to ask any clarifying questions they might have about how to apply the chest seal. From here the participant will walk over to assess either the male or female manikin based on the counterbalance measures of alternating both female and male gendered participants with which manikin they assess first.

The actual experiment consists of assessing both the male and female manikins. Before the participant arrives to the experiment room, the researcher will properly set up both manikins for their assessments. Both manikins will have their heads facing the doorway. The head will be approximately three boot lengths from the door along the wall, and four and a half boot lengths from the wall to the inside of the room.

After watching the training video, participants will then enter the room where they assess the manikin by undressing the upper half of the manikin and placing the chest seal on both wounds. Once they believe they have finished treating the manikin, they inform the experimenter who will then stop the timer and bring them back to the main room. Participants then fill out the post assessment survey for the gender corresponding to the manikin they just assessed. Next, the participant moves on to the second manikin to repeat the same procedures as they did for the opposite sex manikin. Once the participant completes the final assessment of the other manikin and the corresponding survey, they are thanked for their participation and exit the room. The experimenter then records all the data from the participant, including photographing the placement of the chest seals and sanitizing the whole room and all experiment items.

3 Results

A 2 (within: *gender of manikins*) x 2 (between: *gender of participant*) x 2 (between: *order of manikin presentation*) mixed ANOVA was conducted with initial response, exposure, time on task (all in seconds), and chest seal accuracy as the dependent measures. Sphericity was not violated

Initial Response Time

There was no effect of initial response time nor was it significant in any interactions. This implies that participants took a similar amount of time to initially approach the manikins no matter the gender of the participant nor the gender of the manikin.

Exposure Time

The mixed ANOVA revealed a significant effect on the exposure time of the participants with the manikin they are working on $F(1,17) = 7.527$, $MSE = 25.744$, $p = 0.014$. Exposure time is measured as the time from which a participant touches the manikin to when they expose the manikin in which they are working on. The exposure time for operating on the female first ($M = 17.83$, $SE = 7.09$) was greater than the time for operating on males first ($M = 12.33$, $SE = 4.21$).

Time on Task

There was no effect of time-on-task nor was it significant in any interactions. This implies that participants took a similar amount of time applying chest seals no matter the gender of the participant nor the gender of the manikin.

Accuracy

The mixed ANOVA revealed a significant effect of the accuracy of trauma care on the female manikins in comparison to the male manikins $F(1,17) = 8.319$, $MSE = 0.101$, $p = 0.01$. The accuracy of the care on the manikins is measured by the amount of gunshot wounds that they treat out of the two wounds present. Of 21 participants, only 25% of the participants (3 male and 3 female) did not accurately treat the female manikin as they only treated one of the gunshot wounds on the GRK. The missed gunshot wound is located on the manikin's left side of the body and underneath the disposable bra (as seen in Figure 1 previously).

Manikin Order Interactions

The mixed ANOVA revealed an interaction between the order a participant sees the manikin and their response time $F(1,17) = 10.050$, $MSE = 1.562$, $p = 0.006$. Participant's response time is measured from the time they walk through the door to the moment they touch the manikin. It also revealed a trend towards an order effect on which manikin participants see first and their accuracy $F(1,17) = 2.568$, $MSE = 1.562$, $p = 0.121$. The order in which participants sees the manikins is randomized as some participants will see the male or female manikin first, while accounting for the gender of the participant. The ANOVA revealed that the order of the participant working on the manikin significantly impacted the response time $F(1,17) = 10.050$, $p = 0.006$, exposure time $F(1,17) = 8.240$, $p = 0.011$, and time on task $F(1,17) = 5.377$, $MSE = 508.607$, $p = 0.033$. When the female manikin was seen first, participants took longer to assess her than the male manikin. This implies that seeing the male manikin first

primed the participants were to look (since gunshots were in the same location on both manikins).

Fig. 2. Above displays the bunching from one participant' s placement of the chest seal on the female manikin.

A common theme with the gunshot wound on the left side of the manikin towards the axilla is that frequently the cheat seal is applied with significant bunching as seen in Figure 2 above. Notably, on the post-assessment surveys, out of the 19 participants, 11 of them (over 57%) either disagree or feel neutral about whether the Army's current TC3 training adequately prepares them to assess and treat female soldiers.

4 Discussion

The 2x2x2 mixed ANOVA revealed that both male and female participants took significantly longer to expose the female manikin, and there was a tendency to miss wounds on the female manikins and misapply the chest seals. The results reveal that placement of the female chest seals was consistently less accurate compared to the male manikins. The significant amount of bunching of the chest seals is problematic towards the effective use in sealing the wound from leaking air from the lungs. These effects were generally most pronounced when the female manikin was seen first. This initial hesitation and tendency to miss wounds is potentially life-threatening event on the battlefield.

This study reveals the importance of improving TC3 training in the Army, to ensure all soldiers are comfortable treating male and female soldiers. Watching participants confidently not treating both gunshot wounds, incorrectly placing the chest seals, and lacking the confidence with treating the female manikin, is concerning. To best prepare soldiers to assess casualties successfully in combat, the trauma training and manikins should reflect both genders and proper ways to treat them. This study is still ongoing, but our results imply that further research should continue in order to

ensure the Army's TC3 training is the most effective and current to match the Army's current operating environment.

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