Ultrasound Identification of the Cricothyroid Membrane: Speed, Accuracy, and Skill Retention After Rapid Training

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Abstract

Phase II Site: Naval Medical Center Camp Lejeune and Naval Hospital Jacksonville

Project Title: Ultrasound identification of the cricothyroid membrane: Speed, accuracy, and skill retention after rapid training

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Background/Problem: Airway obstruction was the second leading cause of potentially survivable death in recent wars (Walrath et al., 2017). Manual palpation to identify the cricothyroid membrane (CTM) is successful in approximately 30% of attempts (Elliott et al., 2010; Hiller et al., 2016). Ultrasonography to identify the CTM has been shown to provide greater accuracy in live models and cadavers, at the cost of time (Kristensen et al., 2016; Nicholls et al., 2008; Siddiqui et al., 2015; Siddiqui et al., 2018).

Purpose: This project compared speed and accuracy of palpation versus ultrasound-guided CTM identification for healthcare professionals after a brief training session to assess skill acquisition and retention.

Project Design: Participants were assessed on accuracy and time taken to identify the CTM using palpation prior to receiving training. Following an 8-minute training video on ultrasound-guided techniques for CTM identification, participants were assessed on their accuracy and time taken to identify the CTM using ultrasonography. Six-to-eight weeks after the initial training, participants were re-tested on accuracy and time to identify the CTM using ultrasonography.

Analysis of the Results: Identification of the CTM during initial testing was significantly faster than with ultrasonography ($p<.001$) although accuracy was not significant ($p=.391$). There was no statistical significance between provider types for either speed or accuracy of CTM

identification (p-values .202 and .781, respectively). Median accuracy in initial testing was slightly better with ultrasonography than palpation (3.4 mm vs 4 mm from CTM midpoint). Median time to CTM identification was faster with repeat testing (18.5 s) than with initial testing (25 s).

Implications for Practice: Participants demonstrated successful acquisition and retention of this advanced airway skill. This shared mental model can enhance readiness for hospital and combat perioperative teams, providing skills to anticipate and execute cricothyrotomy when other airway interventions are unsuccessful.

Abbreviated Abstract

Project Purpose: Develop, implement, and evaluate the effectiveness of an educational program for identifying the CTM using ultrasonography for the perioperative staff of NMCCL and NHJAX.

Impact: The program will increase staff knowledge regarding airway landmark identification and may improve the care provided for patients with a known or suspected difficult airway. Will enhance readiness for forward deployed hospital and combat perioperative teams.

Ultrasound Identification of the Cricothyroid Membrane:

Speed, Accuracy, and Skill Retention After Rapid Training

Management of a difficult or failed airway can quickly deteriorate into a "cannot intubate-cannot oxygenate" (CICO) situation that may require the creation of an emergency invasive airway (surgical or percutaneous) to provide oxygenation (Apfelbaum et al., 2022; Frerk et al., 2015). The successful placement of an emergency invasive airway requires rapid and accurate identification of anatomical landmarks (Elliot et al., 2010). Correct identification of airway landmarks could mean the difference between restoring proper oxygenation or anoxic injury or death. The cricothyroid membrane (CTM) is the preferred emergency invasive airway site, but the accuracy rate of identification, which is traditionally performed by manual palpation, is approximately 30% worldwide among clinicians who provide airway management (Elliott et al., 2010; Hiller et al., 2016). The cost of failure to establish an emergency invasive airway is real and especially true in military environments. Mabry and Frankfurt (2012) analyzed military battlefield injuries and noted two-thirds of combat injured service members who underwent prehospital cricothyrotomy died. Notably, combat medics were unable to cannulate the trachea in nearly one-fourth of those casualties.

An accurate, clinically validated technique for identifying appropriate airway landmarks should be an initial step toward improving outcomes for patients who are at risk for requiring emergency airway procedures (Hiller et al., 2016). Recent research suggests the use of ultrasound to identify the CTM is more accurate and reliable when compared to manual palpation (Kristensen et al., 2016; Nicholls et al., 2008; Siddiqui et al., 2015; Siddiqui et al., 2018). There is no standardized practice for airway landmark identification at Naval Medical Center Camp Lejeune or Naval Hospital Jacksonville. As a potential solution, standardized

ultrasound-guided training on accurate identification of airway landmarks that can be used prior to airway management when clinically indicated was provided.

Problem Synthesis

The ability of providers of all experience levels to correctly identify the CTM via the current standard of manual palpation is predictably inaccurate. Research demonstrates that anesthesia providers, emergency physicians, and surgeons performed equally poorly in palpating the CTM (Elliot et al., 2010; Hiller et al., 2016; Nicholls et al., 2008). Airway management is vital in trauma resuscitation and surgical anesthesia, thus proficiency with backup airway techniques is imperative. A CICO emergency can occur not only with traumatic airway injury, but also may occur when routine airway placement for surgical anesthesia fails. An emergency invasive airway is created using a needle or a scalpel to make a passage in the anterior neck below the glottis to quickly cannulate the trachea for ventilation in CICO scenarios (Apfelbaum et al., 2022; Frerk et al., 2015).

Accurate and reliable identification of the CTM is crucial in airway emergencies (Heard et al., 2009). The CTM is the preferred site over the trachea for a surgical airway due to its prominence and often easy identification by palpation in many individuals (Heard et al., 2009). The anterior midline space between the thyroid and cricoid cartilages houses the CTM. The most common technique for identifying the CTM is via manual palpation (Frerk et al., 2015), but this technique may not be the best practice. For example, the CTM is poorly identified by palpation and often yields inaccurate localization in many females, parturients, obese individuals, and those with distorted airway anatomy or injuries (Elliott et al., 2010; Lamb et al., 2015; Lavelle et al., 2021). Poor identification of external landmarks is the primary cause of failure for an attempted emergency invasive airway (Elliott et al., 2010; Hamaekers & Henderson, 2011). A

reliable technique that allows for greater accuracy in identifying CTM landmarks is necessary for enhanced cricothyrotomy success, not only for staff in the hospital but also in a military deployed setting.

Relevance to Military Nursing

Airway emergencies are especially prevalent in combat casualties. Walrath et al. (2017) identified that "airway obstruction was the second most common cause of potentially survivable death in all United States combat casualties from October 2001 to June 2011" (p. 2). Additionally, Mabry & Frankfurt (2012) report the rate of cricothyrotomies performed in combat injuries was 0.62% which is nearly twice that of what Schauer et al. (2015) report for the civilian trauma population (0.32-0.36%). In addition to their traditional roles during surgery, physician and nurse anesthesia providers often augment emergency medical personnel and surgeons in trauma resuscitation efforts, both in hospitals and in combat scenarios (Adams et al., 2008; ASA, 2013; Tobin, 2021). The improvement of accurate identification of cricothyrotomy landmarks could reduce morbidity and mortality in both combat and non-combat environments. Further, preparing clinicians for better emergency invasive airway success aligns with the Military Health System's Quadruple Aim goal of *Readiness* to "deliver healthcare anytime, anywhere in support of the full range of military operations" (United States Department of Defense, 2013).

Clinical Question

Because we recognize cricothyrotomy is a rarely performed but essential skill for airway experts, we reviewed the evidence for this question: Among perioperative healthcare providers, does the use of ultrasonography when compared to palpation increase the accuracy of identification of the CTM?

Search Strategy / Results

We searched PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Ovid Medline-All, and Joanna Briggs Institute Evidence Based Practice databases to include articles for this systematic literature review. We used these search terms to retrieve results from the databases: “identification,” “location,” “locate,” “airway,” “trachea,” "cricothyroid membrane," “landmarks,” “placement,” "surgical airway," “emergency,” and “cricothyrotomy.” As of September 24, 2021, these search terms yielded 218 results; 100 were removed as duplicates, which provided 118 articles for review.

For a maximum breadth of information, no publications were excluded by date. Articles were included for review if published in English, study participants used ultrasound to locate the CTM, and live human or cadaver subjects were used for airway anatomy identification. Articles were excluded if the technique of CTM identification was not specifically studied or identified, ultrasound was used by the research staff but not by the participants, or the study’s focus was exclusively on the pediatric population. After an abstract and full-text review, eight articles remained as can be seen on our PRISMA flow sheet (Appendix A). Evidence level and quality of sources were evaluated using the Johns Hopkins Nursing Evidence-Based Practice Evidence Level and Quality Guide (Dang et al., 2022). Three sources were evaluated as level I evidence, two of which were high quality and one was good quality. One source was evaluated as level II evidence with good quality. Three sources were evaluated as level III evidence, with one high quality and two good quality. Finally, one source was evaluated as level V evidence with high quality. An overview of the evidence can be seen on our evidence table (Appendix B) and is reviewed below.

Solution Synthesis

In a narrative review, Alerhand (2018) examined almost four decades of cricothyroid membrane location studies using both palpation and ultrasonography. The author's review found landmark identification via palpation is consistently inaccurate, especially in obese individuals and women. It was noted ultrasound identification is more accurate than palpation, but the tradeoff is a longer time to identification. Additionally, ultrasound identification yields greater accuracy after a brief training course, and the improved accuracy holds true with identification three months after the training period. Importantly, because ultrasound identification adds time to proper location, it is not recommended in the midst of a CICO scenario.

Nicholls et al. (2008) developed a standardized technique for ultrasound identification of the CTM. The authors' technique begins by using the longitudinal orientation of the probe to identify the lateral borders of the CTM, then rotating the probe to the transverse orientation to verify the location of the CTM. Next, they tested this technique on 50 subjects and found successful CTM identification in all 50 subjects. The mean time to CTM identification was 24.3 seconds. The authors suggest ultrasound-guided CTM identification is an efficient and accurate method of assessment to be performed prior to proceeding with rapid sequence induction in patients with an anticipated difficult airway.

Kristensen et al. (2016) compared transverse and longitudinal approaches to ultrasound-guided CTM identification. The authors' transverse method involves a "thyroid-airline-cricoid-airline" or "TACA" technique in which 1) the thyroid cartilage is identified as a triangular structure, 2) the airline of the CTM is identified caudally as hyperechoic lines, 3) the cricoid cartilage is identified further caudally as a horseshoe-shaped structure, and 4) movement cranially back to the airline of the CTM is performed to mark the site for placement.

The longitudinal method tested resembled that of Nicholls et al. (2008). Thirty-eight of the forty-two anesthetists included in this study successfully identified the CTM using at least one of the two techniques. The mean time to CTM identification was 24.0 seconds using the transverse technique and 37.6 seconds for the longitudinal technique. The authors specifically advocate learning and applying these techniques before starting anesthesia in patients with impalpable anatomical landmarks.

Lavelle et al. (2021) examined ultrasonographic CTM identification in obese parturients, with the goals of determining accuracy, time, and ease of use for an experienced anesthetist. With ultrasound use, the distance from the midpoint of the CTM was a mean of 2.5 mm and time to identification was 23.5 seconds. Identification of the CTM using the palpation technique resulted in a mean distance from the midpoint of the CTM of 5.5 mm and time to identification was 16.9 seconds. Ease of use was rated 4.2 out of 10 for the palpation identification versus a 2.4 out of 10 for the ultrasound group. The authors also suggested a 3 mm deviation from midpoint would still provide a proper site for cannulation, so it is reasonable to deduce that the palpation method would have resulted in failure to place the invasive airway.

Curtis et al. (2012) described ultrasound-guided bougie-assisted cricothyrotomy as a novel technique for the insertion of a surgical airway. The authors studied two independent operators utilizing ultrasound guidance using a linear transducer in the longitudinal orientation for CTM identification and performance of cricothyrotomy on 21 cadavers. The median time to identification of the CTM was 3.6 seconds (interquartile range = 1.9 to 15.3 seconds), the median time for completion of the procedure was 26.2 seconds (interquartile range = 10.7 to 50.7 seconds), with a high success rate of 20 out of 21 cadavers. This study demonstrates

ultrasound-guided identification of the CTM is both quick and accurate when used to place invasive airways in cadavers.

Siddiqui et al. (2015) compared cricothyrotomy performed on cadavers with either digital palpation of the CTM or ultrasound-guided identification of the CTM. The authors found ultrasound guidance significantly decreased the incidence of injuries to the surrounding tissues and increased the success rate in cadavers with difficult-to-impossible landmark palpation. The authors suggest ultrasound-guided CTM identification should be performed before airway management, specifically in patients whose neck landmarks are difficult to palpate. Siddiqui et al. (2018) then compared ultrasonography to palpation in the identification of the CTM in subjects with poorly defined neck landmarks. The authors deemed identification within 5 mm from the center a success, citing previously established computed tomography (CT) measurements of the CTM allowed for this deviation. The authors found proper identification of the CTM with ultrasonography in 81% of the subjects and in only 8% with palpation. This study further solidifies the superiority of ultrasound-guided CTM identification.

Arthurs et al. (2020) demonstrated positioning affects CTM location. Positioned at 0, 30, and 90 degrees, subjects' CTM was measured via ultrasound using the TACA technique described by Kristensen et al. (2016). Compared to the 0-degree marking, the CTM displaced cephalad 2.7 mm at 30 degrees and 4.2 mm at 90 degrees. Additionally, the distance of CTM movement from 30 degrees to 90 degrees was greater with a body mass index of 30 or more or at age 70 or greater. Considering the variability with position changes, the authors recommend marking the CTM while supine. Alternatively, marking the CTM while the individual is in the position of planned airway management may be a prudent practice.

The available research literature explored multiple techniques for identification of the CTM; however, the aim of this project was to determine the best technique for accurate CTM identification in preparation for a potential emergency surgical airway based on the current evidence available. Throughout the research previously discussed, ultrasonography is consistently demonstrated as the most accurate technique for CTM identification. Considering the available evidence, the project team included both the transverse and longitudinal techniques identified by Kristensen et al. (2016) for CTM identification in the training video for this project.

Focus Area

Because the evidence demonstrates the identification of the CTM via palpation technique is less accurate than ultrasonography to identify the cricothyroid membrane (Alerhand, 2018) the focus of this project was to assess the accuracy and time to identification of the CTM in the perioperative staff population. Perioperative staff of all levels of experience were briefly trained on how to utilize the ultrasound machine for proper identification of the CTM. Six to eight weeks after initial training and assessment, a follow up was conducted to test whether participants maintained the ability to properly identify airway landmarks via ultrasonography. The goal of teaching perioperative members the ability to correctly identify these emergency landmarks is to ensure a shared foundation of knowledge potentially preventing adverse outcomes related to emergency airway access.

Business Case Analysis

After an assessment of practical alternative methods of training for CTM identification, the project team chose to use a live human model for ultrasound-guided CTM identification. Using a live human model provided the most realistic experience, anatomical landmarks, and tissue appearance. The value of this implementation was based on decreased morbidity and

mortality, improved staff training and competence, and augmented operational readiness. Moucharite et al. (2021) reported difficult intubation alone was associated with $14,000 higher in-patient stays, four days longer hospital stay, higher likelihood of intensive care unit stay, and two days longer stay in the intensive care unit. Experienced operators can perform CTM identification via ultrasound-guidance in as little as 3.6 seconds (Curtis et al., 2012). Additionally, adding this skill to the standard Trauma Combat Care Course, knowledge can help operational forces provide more advanced care, potentially improving survival rates of forward-deployed personnel. Full details are provided in the Business Case Analysis (Appendix C).

Organizing Framework

The Johns Hopkins Nursing Evidence-Based Practice Model (Dang et al., 2022) (Appendix D) was an exceptional fit for exploring the best practice of CTM identification. Over its 20 well-defined steps, the model divides the process into three categories: developing the practice question, searching for the available evidence, and translation of the evidence into a practice change. The project team developed the practice question through discussion with senior mentors and identification of the need for standardized knowledge and skills in the event of emergency invasive airway events. Search for the relevant evidence among the available research literature was exhaustive, and the real-world implications of combat-related airway management failure was well-explored. Finally, the evidence was translated into a targeted approach to training civilian and military medical providers in ultrasound-guided airway identification, which can yield a high reward of saved lives with limited monetary cost.

Project Design

General Approach

The project team provided standardized training on how to identify the CTM with an ultrasound-guided technique to the perioperative staff of Naval Medical Center Camp Lejeune (NMCCL) and Naval Hospital Jacksonville (NHJAX). Prior to the training, accuracy and speed of the current practice of palpation for CTM identification was evaluated. After the training, the palpation results were compared with the accuracy and speed of CTM identification utilizing an ultrasound-guided technique.

Setting and Population

The project implementation spanned two US Navy healthcare facilities. NMCCL is in Jacksonville, North Carolina. It is a level III trauma center with 205 in-patient beds, eight operating rooms, and provides the following surgical services: Ear/Nose/Throat, General Surgery, Oral and Maxillofacial Surgery, Orthopedics, Obstetrics and Gynecology, Podiatry, and Trauma (Tricare, n.d.a). NHJAX is a mid-sized military community hospital located in Jacksonville, Florida, with 64 in-patient beds and six operating rooms. Surgical services include Ear/Nose/Throat, General Surgery, Oral and Maxillofacial Surgery, Orthopedics, Obstetrics and Gynecology, and Podiatry (Tricare, n.d.b).

The focused population for implementation of the project was the perioperative staff of NMCCL and NHJAX. Certified registered nurse anesthetists, physician anesthesiologists, perioperative nurses, civilian perioperative technicians, and Navy hospital corpsmen whose varied skill sets included preoperative patient preparation, intraoperative surgical management and assistance, and postoperative anesthesia recovery were included.

Procedural Steps

The initial testing and training session was conducted in one day at each testing site. A standardized military male human model at each location was used for high fidelity testing. The models laid supine on a hospital gurney with their head supported on a rolled towel. The center of the CTM was located on the models via ultrasound by the project leaders and it was marked with ultraviolet (UV) light-sensitive markers. An adhesive transparent film was placed over the UV-sensitive mark to allow for repeated marking with a dry erase marker during identification by participants. The models then remained as motionless as possible throughout the testing. A demographics survey was provided to each participant to assess their perioperative role and prior airway skills obtained, especially in locating the CTM (Appendix E). Prior to providing the participants any primer education on locating the CTM, each participant was instructed to palpate the neck of the standardized human models to find the center of the CTM and to mark the center with a dry erase marker. Time was recorded via personal mobile phone devices and distance was recorded with digital calipers. The time to identification and distance from the center of the CTM was recorded. Then, a brief training video created by the authors was presented to the participants. In this video, basic ultrasound principles, the anatomy of the cartilaginous neck structures required for identification of the CTM, and two different ultrasound-guided techniques identified in the literature for accurate location were discussed. Figure 1 shows the anatomical location on a plastic model for which each ultrasound view could be obtained on the human model. The transverse ("TACA") and longitudinal ("string of pearls") views provided in Figure 1 were demonstrated on a live model during the instructional video. The participants were then instructed to use a pre-set ultrasound configuration with the ultrasound probe prepared with ultrasound gel to locate and mark the center of the CTM without

palpating the neck. Time to identification and distance from the center of the CTM were recorded. After six to eight weeks, the same human models were prepared in the same fashion as before, and only participants who attended initial training and testing returned and were again instructed to use ultrasonography to locate the center of the CTM. No additional education or reminders were provided to participants for the repeat execution of this task, and participants were not allowed to palpate to aid with location. Time to identification and distance from the center of the CTM were recorded as before.

Data Analysis Plan

For data analysis, accuracy and time to CTM identification with palpation prior to training versus accuracy and time to identification of the CTM with ultrasonography after training were compared (Appendix F). A p-value less than .05 was determined as statistical significance for the findings. An analysis of variance (ANOVA) was performed to evaluate the significance of any difference in results for each skilled provider type, and Wilcoxon testing was performed to evaluate the significance of speed and accuracy comparison of the two identification methods. Funding for statistical analysis was provided by the Tri-Service Nursing Research Program (TSNRP).

Potential Barriers

Several potential barriers were identified, and mitigation strategies were developed for each. Difficulty finding a sufficient number of initial participants was reduced by working with perioperative leadership to coordinate training sessions that worked well with the surgical schedule. This coordination promoted buy-in from leadership and reduced scheduling conflicts that might have eliminated participants. Further participant attrition during the retesting session was also a barrier, but continued communication with leaders was helpful in retaining

participants. Additionally, testing sessions were conducted in the centrally-located Post Anesthesia Care Unit, so participants did not need to leave their workspace to attend. Different training staff at two separate locations might have resulted in variation in training, so the same training presentation, materials, methods, and supplies were used at each site.

Sustainment and Dissemination Plan

After data analysis, the results were shared with the perioperative staff and leadership at the naval hospitals and with Uniformed Services University clinical site faculty. Dissemination of this project to the Uniformed Services University of Health Sciences will be via manuscript, academic poster, and presentation. The findings have also been submitted for presentation at the TSNRP conference and the NMCCL Research Symposium. In addition, the manuscript has been submitted for review by a peer-reviewed journal for future publication.

Health Insurance Portability and Accountability Act (HIPAA) Concerns/Ethical Considerations

This project was given exempt status from the internal review board at each facility. Additionally, information collected from participants, in the form of two demographics surveys, was limited to occupation, experience, and whether the participants had prior experience related to emergency airway procedures and ultrasonography. This information was stored on a password protected file, in a password protected computer, and in a locked office. To preserve anonymity, each participant created their own unique numerical identifier. The participants provided that number on their demographics surveys and to the evaluator for testing results. This approach to information collection prevented the participant from providing any personally identifiable information while allowing the investigators to track and analyze data accurately.

Project Results

CTM identification speed and accuracy were assessed for 63 participants during the initial training and testing sessions. Of those participants, 31 returned for repeat testing after six to eight weeks. The participants' skill characteristics are described in Table 1. Seventy-one percent of the participants had five or fewer years of experience in their current healthcare role. Speed and accuracy results are provided in Figure 2 and Table 2. No statistical significance between provider types for either speed or accuracy of CTM identification was found (p-values .202 and .781, respectively). Accuracy with palpation versus ultrasound was not statistically significant (p=.391). Speed of palpation was significantly faster than with ultrasonography (p<.001).

Analysis of Results

During initial testing, CTM identification by palpation was significantly faster than ultrasonography. Although not statistically significant, median accuracy in initial testing was slightly better with ultrasonography than palpation (3.4 mm vs 4 mm from CTM midpoint). After six to eight weeks, participants were faster (median time to CTM identification with initial testing was 25 seconds and repeat testing was 18.5 seconds) and remained accurate in ultrasound-guided CTM identification. Repeat testing showed less variance for time and distance. Median palpation and ultrasound measurements were within the 5 mm maximum allowable deviation from the center of the CTM identified by Siddiqui et al. (2018). The brief airway ultrasound training resulted in clinically significant accuracy in ultrasound-guided location of the CTM that was sustained six to eight weeks post-training. The increased speed demonstrated in the six-to-eight-week interval after training may improve identification time in an airway emergency.

This skill was successfully taught to and demonstrated by perioperative staff members with a variety of skill sets, ranging from airway experts to medical technicians. This shared mental model with multiple ultrasound-trained team members may better allow for rapid CTM location during an emergency when the person performing the procedure encounters difficulty. Preoperative CTM identification in cases of anticipated difficult airway may also be a valuable strategy in airway management. A head-of-bed elevation angle change can significantly alter CTM position (Arthurs et. al, 2020), so pre-marking of the CTM for an anticipated difficult airway should be done in the same position a cricothyrotomy would be performed.

Limitations

Demographic differences related to training, sample size, and location limit generalizability of findings to the institutions where the project was conducted. This project included a small convenience sample within the local institutions, which was representative of military treatment facilities of comparable size due to a mix of civilian and military staff make-up. All military medical staff are required to attend emergency airway training during the Tactical Combat Casualty Care (TCCC) course (United States Department of Defense, 2022), but only manual palpation techniques are routinely taught due to the austerity of front-line combat. Civilian staff without such training were also among our participants. The airway models were males with a body mass index (BMI) less than 30 with no known airway deformity, which is less consistent with the populations in which airway anatomy is more difficult. The ability to better locate the CTM in such populations is well-established for airway experts (Lamb et. al, 2015; Siddiqui, 2015; Siddiqui, 2018), but the focus of this project was more directed at testing the ability to rapidly teach this technique to various staff - those with airway and ultrasound experience and those without. Additionally, the initial session occurred during the same time as

training for the new electronic health record roll-out and this limited our participant pool. Importantly, anesthesia providers were a relatively small portion of our participant group. Obtaining the majority of data from those less familiar with airway management and ultrasound use may have increased the time and reduced the accuracy of location; however, it provided the opportunity to better assess the efficacy of the standardized training provided.

Additionally, some participants acknowledged the correct center of the CTM on the ultrasound monitor, but due to unfamiliarity with the ultrasound machine marked the center erroneously outside the ultrasound probe's beam. Due to this, the median measurement may have been more accurate with more training on ultrasound considerations. The dry-erase marker was sometimes difficult to see when participants attempted to mark the CTM with ultrasound gel present, so additional time was taken to indicate the intended marking site, potentially increasing the average time with the ultrasound technique.

Organizational Impact / Implications to Practice and Policy

In battlefield medicine, the first responder is usually a hospital corpsman with TCCC as the base level of training (US Department of Defense, 2022). In deployed military settings, perioperative staff augment emergency personnel in trauma resuscitation. This project implemented training to perioperative healthcare professionals on ultrasonography techniques for CTM identification with the primary focus on providing a retainable skill that could be utilized in preparation for an emergent cricothyrotomy. Training implementation demonstrated surgical support staff, nurses, and anesthesia providers were able to retain this evidence-based skill to accurately identify the CTM via ultrasonography. This project suggests teaching all members of the resuscitation team the ability to correctly identify the CTM encourages a shared mental model, with the goal of preventing failed emergency airway access.

Future Directions for Research and Practice

Future studies could include similar ultrasound-guided airway training for perioperative staff with mixed skill sets, then assessing their identification accuracy and time on models who are female, pregnant, obese, and/or with airway distortion. Actual or simulated cricothyrotomy on cadavers, animals, or high-fidelity manikins could further demonstrate the efficacy of training. Assessment of ultrasound-guided identification of CTM in operational settings with operational equipment could provide valuable information about the practical application of this skill in military operations.

Conclusion

The project team conducted an evidence-based project comparing the accuracy and time to CTM identification by palpation and ultrasonography. Rapid training was provided to perioperative healthcare providers of all skill levels at NMCCL and NHJAX about how to identify the CTM using ultrasonography. The data collected mirrored the findings in the literature review. Identification of the CTM using palpation was faster than the initial use of the ultrasound-guided technique but there was no statistically significant difference in accuracy. In repeat testing of the ultrasound-guided technique, speed improved and accuracy remained consistent. These results suggest this skill is teachable to all levels of healthcare providers and is retainable. The authors recommend extending training of CTM identification with ultrasonography to all areas of military medicine.

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Figure 1. Transverse (top three images) and longitudinal (bottom image) ultrasound views of CTM.

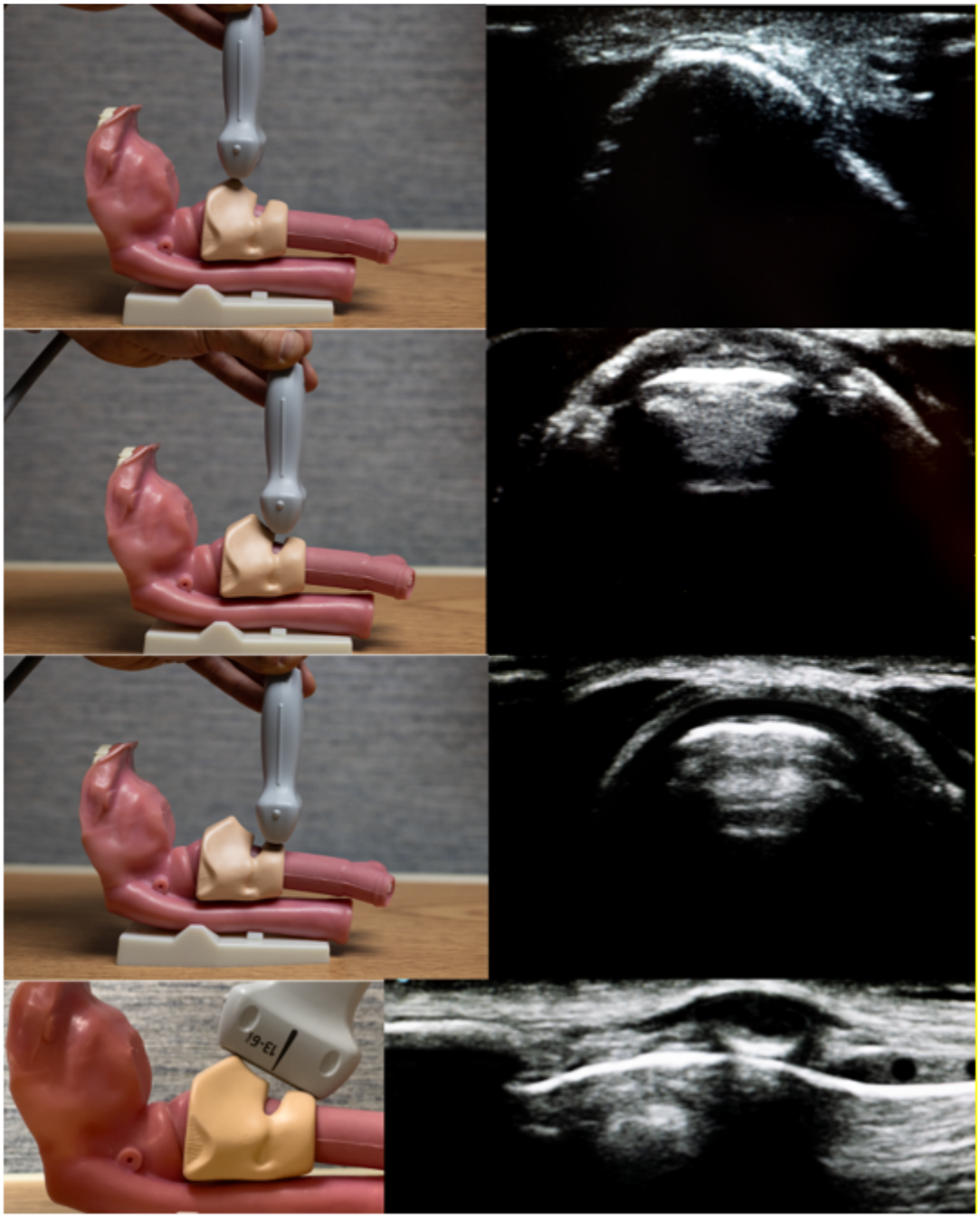


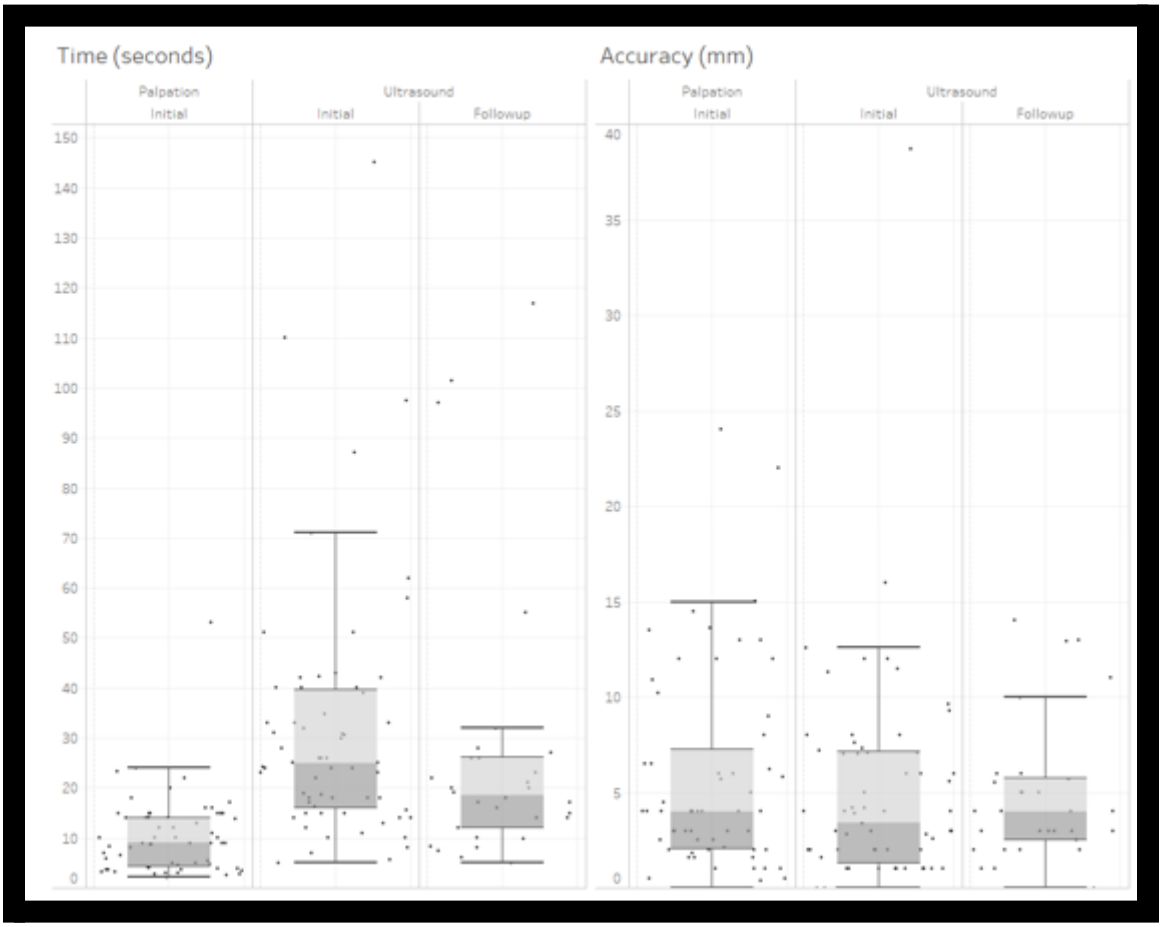
Table 1. Demographic data

Provider type	**Number of participants for initial test (n=63)**	**Number of participants for repeat test (n=31)**
Physician anesthesiologist	2	1
CRNA	6	4
RN	13	5
HM	42	21

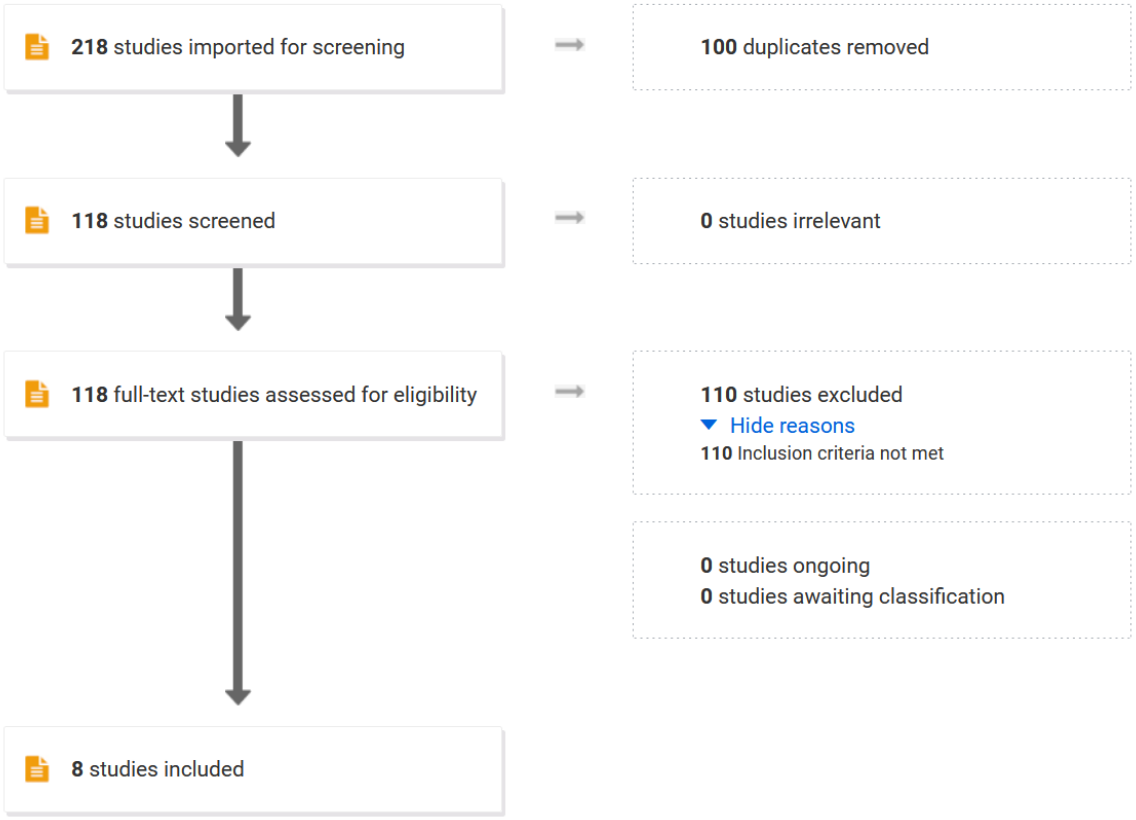
Table 2. CTM identification results

Technique	**Median distance from center (mm)**	**Median time to location (secs)**
Palpation	4	9
Ultrasound, initial test	3.4	25
Ultrasound, repeat test	4	18.5

Figure 2. CTM Identification Results



Appendix A
PRISMA Diagram



Appendix B
Evidence Table

1st author (year)	Study Design	Sample size	Aim	Variables	Results	Level of Evidence
Alerhand (2018)	Narrative review	18 articles reviewed	Review of prospective studies	I: Identification of the CTM via palpation or ultrasound D: Accuracy and time to identification; difficulty of identification; retention of training	CTM identification via palpation is not sufficiently accurate. CTM identification via US is more accurate. The US method does take longer.	V-A
Arthurs et al. (2020)	Prospective observational study	106 subjects	Measured difference in position of the CTM using US at different head of bed (HOB) positions; determine if difference was affected by patient factors	I: HOB at 0, 30, 90 degrees D: US was used to identify CTM. CTM was measured at HOB 0 and used as a reference landmark. Distance from this point was measured at 30 and 90 degrees Descriptive data was also collected.	There is a cephalad change of 2.7mm at HOB 30 degrees and 4.3mm at HOB 90 degrees. BMI and age >70 were associated with a larger position related change.	III-A
Curtis et al. (2012)	Descriptive study (no control)	21 cadavers	Develop US-guided technique for emergent open cricothyroidotomy on cadaver subjects	I: None - descriptive study – same US guided technique was used for all cricothyroidotomy D: Time of procedure and of identification of the CTM; dissection was used to confirm correct placement	Median time to CTM identification was 3.6 seconds. Median time to endotracheal intubation was 26.2 seconds. 1 failure noted (inaccurate identification of CTM)	III-B
Kristensen et al. (2016)	Randomized cross-over comparison	42 participants	Compared the time to CTM identification using the transverse US technique vs. the longitudinal US technique	I: Transverse or longitudinal US method D: Time to identification of CTM and success rate of identification	Transverse technique was faster than the longitudinal technique (24 seconds vs 37.6 seconds). Correct identification using either method was achieved by all participants.	I-A
Lavelle et al. (2021)	Prospective observational investigation	1 participant, 28 subjects	Determine accuracy of CTM identification via palpation or US in parturient subjects	I: CTM identification using palpation or ultrasound D: Distance from reference mark; time to identification; perceived ease of identification	Distance from the reference mark (middle of CTM) to the participant identified mark was shorter when US was used (2.5mm difference with US and 5.5mm difference with palpation).	II-B
Nicholls et al. (2008)	Prospective observational trial	50 subjects	Develop a reliable US technique for CTM identification and apply it to a variety of ED patients to determine accuracy of technique	I: US technique used to identify CTM D: Accuracy and Time to identification	CTM was identified in all subjects and median time was 24.32 seconds.	III-B
Siddiqui et al. (2015)	Randomized prospective single blind study	47 participants	Participants performed a cricothyrotomy on cadavers using either palpation or US to identify CTM.	I: Method of performing CTM identification – palpation or US D: Rate of injury; insertion time; failure rate	Mean insertion time with US was longer than with palpation (196.1 sec vs 110 sec). Higher incidence of moderate to severe injury with palpation. Greater success of placement with US.	I-A
Siddiqui et al. (2018)	Randomized prospective single-blind clinical trial	223 subjects	Determine accuracy of CTM identification with palpation compared to US	I: Method of performing CTM identification – palpation or US D: Accurate identification (within 5-mm from the CT point)	Accuracy was greater in the US group vs the palpation group (81% vs 8%).	I-B

Appendix C
Business Case Analysis

BUSINESS CASE WITH VALUE BASED CARE ASSESSMENT
Proposed Title for Project/Initiative/Opportunity to Improve
Identification of Emergency Airway Landmarks: Implementation of Ultrasound Training Among Perioperative Staff
Opportunity Statement *(Description of proposed project/initiative/opportunity to improve)*
Provide training to the perioperative staff of NMCCL and NHJAX on how to identify the cricothyroid membrane (CTM) utilizing an improved evidence-based ultrasound-guided method. If initial training results are positive for increased accuracy of CTM identification, we plan to propose an update to the anticipated difficult airway standard of practice to include preoperative CTM identification with ultrasound for patients identified as high probability of difficult airway/difficult surgical airway.
Business Opportunity/Objectives *(Prioritize listing – macro and micro objectives)*

- Increase competence in life-saving skills in healthcare professionals
  - Increase competence in using ultrasound guidance to identify the CTM
  - Decrease the time needed to identify the CTM, leading to decreased placement time for an emergent surgical airway
  - Potential decrease in patient complications related to inaccurate identification of the CTM
- Increase operational readiness for military healthcare professionals
  - Solidify concepts learned in Trauma Combat Casualty Care
  - Provide a more accurate method for identification of CTM

Potential Impact of the Initiative/Project *(Identify outcome metrics & benchmarks/and how objectives align with Quadruple Aim, Value Based Care, and HRO goals)*

- Using ultrasound-guidance to identify the CTM is more accurate than current palpation technique. This will be measured by testing the participants on their identification proximity to the actual CTM and the time taken to identify the CTM.
- This initiative aligns with the Quadruple Aim of the Military Health System to improve healthcare professionals' readiness by ensuring they have the best life-saving skills.
- This allows healthcare professionals to provide better care and potentially better health by reducing complications of emergent surgical airway placement.
- Identification of airway landmarks prior to emergency situations can provide staff with valuable information necessary to correctly perform emergency airway procedures. This could decrease costs associated with failed emergency airway attempts and longer hospital stays.

Alternatives (courses of action) chosen for Analysis
1. Utilization of ultrasound-guidance for CTM identification on a live human subject. 2. Utilization of ultrasound-guidance for CTM identification on a cadaver subject. 3. *"Status Quo"*: Utilization of palpation for CTM identification on a training mannequin.

Analysis of Alternatives		
Alternative 1:	Utilization of ultrasound guidance for CTM identification on a live human subject.	
Pros	**Cons**	
- This is the most accurate method based on the evidence - Realistic experience, anatomical landmarks, and tissue appearance	1. May take more time than palpation but is more accurate upon first attempt 2. Requires specialized training 3. May be difficult to find patient participants for training	
Alternative 2:	Utilization of ultrasound guidance for CTM identification on a cadaver subject.	

Pros	Cons
- Use of cadavers would have more accurate anatomy when compared to training mannequins - More realistic ultrasound image in cadaver when compared to utilizing an ultrasound on a training device.	- Cadaver tissues do not appear the same as live tissue - May be difficult to secure cadaver for this project

Alternative 3:	*"Status Quo":* Utilization of palpation technique for CTM identification on a human model or training mannequin.

Pros	Cons
- Quick method for identification attempt - No new training needed - Easier to conduct the implementation trials with mannequins	- Not as accurate compared to ultrasound-guided method - Training mannequin anatomy is least comparable to human anatomy of the training options - Training mannequins may differ from the two clinical sites involved in the project

Assumptions
- Identification of the CTM using the standard palpation is accurate only 32% of the time by anesthesia providers (Elliot et al., 2010). - Accurate identification of the CTM using the standard palpation takes, on average, 14 seconds (Bair & Chima, 2015). - Accurate identification of the CTM using ultrasound-guidance takes, on average, 24.3 seconds (Nicholls et al., 2008). - The accurate identification of the cricoid membrane is imperative in reducing complications and failure in placing emergent surgical airways (Elliot et al., 2010). - Using ultrasound-guidance to identify CTM reduced complications in cadavers significantly (Siddiqui et al., 2015). - The rate of cricothyrotomies performed in combat injuries is almost twice that of the civilian trauma population (Mabry & Frankfurt, 2012) - Combat medics were unable to cannulate the trachea in nearly one-fourth of combat injured service members who underwent prehospital cricothyrotomy and died (Mabry & Frankfurt, 2012).

- 86% of anesthesia providers report they *always* have daily access to an ultrasound machine (Kristensen et al., 2016).

Recommendation and Rationale

Recommendation

Proposal to recommend alternative #1: Utilization of ultrasound guidance for CTM identification on a live human subject for training. If initial training results are positive for increased accuracy of CTM identification, plan to propose update to the anticipated difficult airway standard of practice to include preoperative CTM identification with ultrasound.

Rationale

Emergency cricothyroidotomy may be more successful when providers have a more accurate method of identification of the CTM prior to attempted airway placement.

Value Based Care - Investment Required by the Organization and the Associated "VALUE" or $ GAINED.

I. Value projected based on:

Decreased morbidity and mortality	With improved technique for accurately finding the appropriate airway landmarks there is potential for decreased adverse events due to failed airway events. Although reports of the financial cost of emergency cricothyroidotomy are scarce, difficult intubation alone has been associated with **$14,000** higher inpatient stays, 4 days longer hospital stay, higher likelihood of ICU stay, and 2 days longer stay in the ICU (Moucharite et al., 2021).
Improved Training and Staff Competence	More staff being trained in US use can increase the number of resources available in an emergent situation. Ultrasound identification has been performed in as little as 12 seconds to 36 seconds after a short course of instruction, so surgical start time impact is expected to be minimal to none.
Benefit to Operational Readiness	Adding to TCCC knowledge and skillset can help operational forces provide more advanced care to improve survival rates of forward-deployed personnel

Increased Patient Safety and Satisfaction	Ensuring the best practices are being utilized will help ensure we are keeping patients as safe as possible, decreasing morbidity and mortality rates. Closed claim costs associated with airway trauma cost ~**$25,000** per case (Domino, 1998).
Decreased length of stay in intensive care unit	Average cost of ICU inpatient stay requiring mechanical ventilation is ~ **$31,574 - 42,570** (Dasta et. al, 2005)

II. Cost projected based on:

Supplies needed	To ensure staff have the equipment necessary to perform ultrasound technique. MTFs consistently have ultrasound capability in critical areas. Need for additional equipment is unlikely; however, included will be one ultrasound per location. Each ultrasound machine costs about **$30,000** (FujiFilm Sonosite, 2021).
Time required for training	Staff will have to spend time in training and away from routine duties, which may affect productivity but likely not predetermined manning cost. On average, the national hourly wage for perioperative staff (including MD, CRNA, RN, LPN, Medical Assistant) is **$58.88** per hour (United States Bureau of Labor Statistics, 2021).
Development of training program	Development and implementation of a new training program will best succeed with new job duties and/or job positions to ensure appropriate information is being disseminated

III. Projected Value:

Decreased Costs:	Difficult intubations/airway costs: ICU admission average costs: Closed claim costs: Total	$14,000 $37,000 $25,000 **$76,000**
Increased Costs:	+/- Ultrasound for preoperative unit:	$30,000

	Average staff member training cost: $3,600 (60 staff members training for 1hr) Total **$33,600**
Total:	**+$42,400/yr**

Risks and Mitigation Plan	
Risks	**Plan**
1. Low participation	Coordinate with perioperative leaders to schedule this training during unit training time to ensure maximum participation.
2. High attrition of participants in the retesting phase	2. Coordinate with perioperative leaders to schedule the retest during unit training time and ensure all participants are aware of follow up dates and provide reminders.
3. Data suggests that ultrasound-guidance is not more accurate than the palpation method in our facilities	3. Return to "*Status Quo"* method of palpation to identify the CTM

Implementation Plan		
Phase 1:	Gather evidence	
Milestone Description:	Conduct literature search about the best method for identifying the CTM.	
Deliverables	Due Date	Accountable Person
Measurable goal: Organization, categorization, and critique of at	One month	Principle Investigator

least 8 systematic reviews, meta-analyses, appropriate well-designed studies, and expert opinions.		
Resources Needed		
Access to research databases; time to perform tasks; and article organization program. Mitigate risk by utilizing USUHS Learning Resource Center capabilities to ensure adequate database searches and organization of results.		
Expected Level of Benefit		
This is the foundation of the project's evidence-based support and without conclusive evidence, this project would fail to meet its purpose.		
Phase 2:	Dissemination of findings (or project approval)	
Milestone Description:	Write the proposed project plan and route it through the approval process.	
Deliverables	Due Dates	Accountable Person
Measurable Goal: Produce a professional presentation and paper and submit it for approval through the appropriate avenues.	One month after completion of data collection (2 months total)	Principle Investigator
Resources Needed		
Time to perform tasks and access to professional technical support to include obtaining an account to the electronic Institutional Review Board. Mitigate risks by collaborating with colleagues and experts to ensure presentation quality and accuracy.		

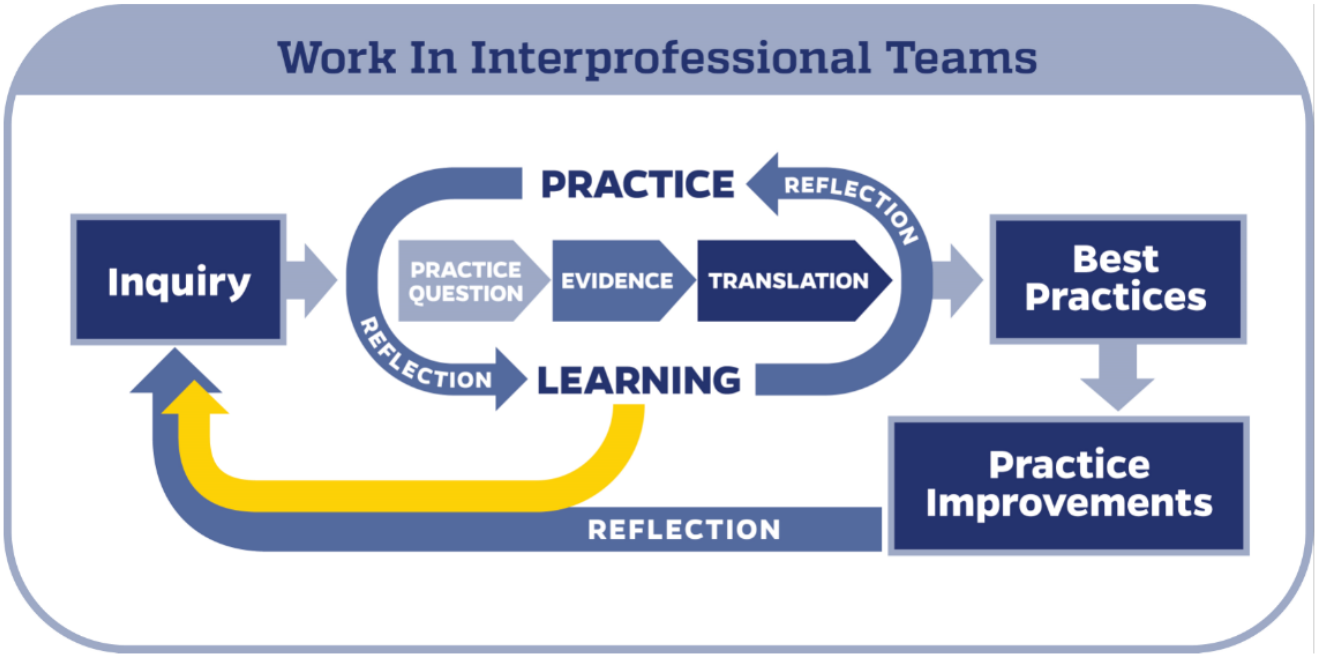
Expected Level of Benefit		
Dissemination to executive leadership allows the decision to be approved through the Institutional Review Board. Additionally, it describes the program's importance and viability.		
Phase 3:	Develop the training and evaluation program.	
Milestone Description:	Develop an evidence-based training program. Write the procedures and methods to serve as a go-by for conducting this project. Identify personnel to serve as the roles described in the procedures and methods.	
Deliverables	Due Dates	Accountable Person
Measurable goals: Produce detailed written procedures and methods with a detailed training program.	One month after program approval 3 months total)	Principle Investigator
Resources Needed		
Time to perform tasks to include procurement of supplies and reservation of all needed spaces. Identifying personnel to fill needed roles and ensure adequate training of the procedures and methods. Mitigate risks by ensuring each clinical site is conducting the program in the same manner with the same equipment.		
Expected Level of Benefit		
Selecting key personnel to perform needed roles will integrate the "buy-in" and maximum participation. Additionally, having detailed written procedures and methods will ensure that each site is conducting the training and evaluation in the same manner.		
Phase 4:	Conduct training program and collect data	
Milestone Description:	Implementation of training and evaluation of participants' identification of CTM via palpation and ultrasound-guidance.	

Deliverables	Due Dates	Accountable Person
Measurable goal: To have 60 participants at both clinical sites	NHJAX - 15-17 February 2022 MNCCL - 2-4 February 2022	Principle Investigator and Project Members
Resources Needed		
Handouts and flyers with training information. Time for all participants and project members to attend training sessions (one hour for participants). Utilization of Staff Education and Training resources and space. All supplies. Mitigate risks by engaging department leadership to encourage participation.		
Expected Level of Benefit		
Increased training and readiness of participants and the ability to accurately identify the CTM which is an imperative step when placing an emergent surgical airway.		
Phase 5:	One month follow up demonstration and data analysis	
Milestone Description:	Re-evaluation of participants' ability to accurately identify the CTM with ultrasound-guidance at two months after initial implementation.	
Deliverables	Due Dates	Accountable Person
Measurable goal: To have at least half the participants attend the re-evaluation sessions at each site.	NHJAX - 19-21 April 2022 NMCCL - 30 March - 1 April 2022	Principle Investigator and Project Members

Resources Needed
Handout with re-evaluation session information. Time for all participants and project members to attend re-evaluation sessions (no more than one hour for participants). Utilization of Staff Education and Training resources and space. All supplies. Mitigate risk of attrition by engaging with department leadership and provide reminders to participants.
Expected Level of Benefit
Provides the data required to determine if ultrasound-guided identification of the CTM is more accurate than palpation in a group of mixed-experience staff with emergency cricothyrotomy training.

NOTE: Modified from Harvard Business Review Press. (2011). *Pocket mentor: Developing a business case.* Boston: Author (pp 82-85).

Appendix D
Johns Hopkins Nursing Evidence-Based Practice Evidence Level and Quality Guide



Appendix E
Pre-testing Demographics Survey

1. What is your unique identifier? _____
   (Suggestion: The number of your street address AND your favorite color, like "1623-Green")
   *This number will be used today and during the re-test on _____; please remember your unique identifier.

2. Circle your current medical role (HM, RN, MD/DO, APRN)?
   Specialty:_____ (Write in)
3. How many years of experience do you have in your current medical role, AFTER the time you completed your initial training? (corps school; residency; graduation; etc)
   - ☐ 0-5 years
   - ☐ 5-10 years
   - ☐ Greater than 10 years

4. What previous training on identification of the cricothyroid membrane have you completed? (Select ALL that apply)
   - ☐ Live patient with actual surgical airway insertion
   - ☐ Ultrasound
   - ☐ Palpation
   - ☐ Cadaver
   - ☐ Animal
   - ☐ Mannequin

5. How confident are you in your own ability to identify the cricothyroid membrane using PALPATION?
   - ☐ 1 - Not at all confident
   - ☐ 2 - Somewhat confident
   - ☐ 3 - Confident
   - ☐ 4 - Very confident

6. How confident are you in your own ability to identify the cricothyroid membrane using ULTRASOUND?
   - ☐ 1 - Not at all confident
   - ☐ 2 - Somewhat confident
   - ☐ 3 - Confident
   - ☐ 4 - Very confident

Appendix F
Post-testing Demographics Survey

1. Did you attend the training session within the past 6 weeks on how to identify the cricothyroid membrane using ultrasonography?
   ___ YES (proceed) ___ NO (that's OK, you will still have a chance to demonstrate later)

2. What is your unique identifier? _____ (Reminder example: The number of your street address AND your favorite color, like "1623-Green"). Please use the one you listed in the first session.

3. How confident are you in your own ability to identify the cricothyroid membrane using PALPATION?
   - ☐ 1 - Not at all confident
   - ☐ 2 - Somewhat confident
   - ☐ 3 - Confident
   - ☐ 4 - Very confident

4. How confident are you in your own ability to identify the cricothyroid membrane using ULTRASOUND?
   - ☐ 1 - Not at all confident
   - ☐ 2 - Somewhat confident
   - ☐ 3 - Confident
   - ☐ 4 - Very confident

Appendix G
Data Analysis Plan

Population or Event	Variable Name	Variable Description and type of measure	Data Source	Possible Range of Values	Level of Measurement	Time Frame of Measurement	Time Frame for Collection	Statistical Test	Decision Rule
Independent Variable	CTM Identification via ultrasound training	Description: Military Healthcare providers receive an educational intervention on ultrasound-guided approach to CTM identification. Process Measure	Staff Training Records	0=before training (via palpation) 1=after training (via ultrasound)	Nominal	Phase II Site dependent	Phase II Site dependent	None	N/A
Dependent Variable Event	% of accurate CTM identification	Primary: The % of accurate CTM identification (within 5mm of the center of CTM) with current practice (digital palpation) BEFORE and ultrasound AFTER education provided; Secondary: time to identification; providers' self-reported confidence	Measurement with digital calipers (or if cost prohibitive, a ruler)	0-100%	Interval	Phase II Site dependent	Phase II Site dependent	Paired t-test or Wilcoxon's signed rank test	Based on literature

Appendix H
Project Timeline

- Develop practice question - **1 Oct 2021**
- Literature review of most accurate CTM identification method - **15 Nov 2021**
- Communicate with clinical leadership to determine best dates/times for our implementation training and retesting (Feb 2022 and March/April 2022) - **1 Dec 2021**
- Schedule training sessions: **13 Dec 2021**
- IRB submission and approval - complete by: **13 Dec 2021**
- Secure training location - PACU with AV equipment - complete by: **15 December 2021**
- Secure trainers and subjects for each location - complete by **1 Jan 2022**
- Ensure all supplies needed for training and testing are present - complete by: **1 Jan 2022**
- Create training presentation - complete by: **1 Jan 2022**
- Conduct practice training and make edits - complete by: **5 Jan 2022**
- Create demographics surveys - complete by: **10 Jan 2022**
- Disseminate advertising of training and confirm with clinical leadership - complete by: **15 Jan 2022**
- Conduct training sessions and gather participant data
    - NMCCL: **2-4 Feb 2021**; NHJAX: **15-17 Feb 2022**
- Conduct retest session and gather participant data
    - NMCCL: **17-18 Mar 2022**; NHJAX: **29 Mar and 1 Apr 2022**
- Analyze data - complete by: **31 May 2022**
- Disseminate data - complete by: **May 2023**

Appendix I
Team Mentor Agreement Form

Appendix B: Daniel K. Inouye Graduate School of Nursing
Topic Selection and Senior Mentor Agreement Form

DOCTOR OF NURSING PRACTICE PROJECT
Topic Selection and Senior Mentor Agreement Form

Graduation Year:

Name(s) of DNP Project Student Team:

1. Julianne Oates	Phase II Site: NMCCL	AGCNS ☐ FNP ☐ PMHNP ☐ RNA ■ WHNP ☐
2. Stephen Duncan	Phase II Site: NMCCL	AGCNS ☐ FNP ☐ PMHNP ☐ RNA ■ WHNP ☐
3. Randall Barlow	Phase II Site: NHJAX	AGCNS ☐ FNP ☐ PMHNP ☐ RNA ■ WHNP ☐
4.	Phase II Site:	AGCNS ☐ FNP ☐ PMHNP ☐ RNA ☐ WHNP ☐
5.	Phase II Site:	AGCNS ☐ FNP ☐ PMHNP ☐ RNA ☐ WHNP ☐
6.	Phase II Site:	AGCNS ☐ FNP ☐ PMHNP ☐ RNA ☐ WHNP ☐

DNP Project Topic Area:

Emergency invasive airway access is required when non-invasive methods fail in a "can't intubate, can't ventilate" scenario. The site of choice is the cricothyroid membrane (CTM). Identification of the CTM is currently performed via palpation, but poor accuracy can result in failure to place an invasive airway. Ultrasonography provides a more accurate method to identify the CTM, but often at the cost of speed. Training the perioperative staff at NMCCL and NHJ in sonographic techniques to locate the CTM may provide a foundation of shared knowledge for more efficient assessment of a patient with a known or suspected difficult airway and placement of an emergency invasive airway.

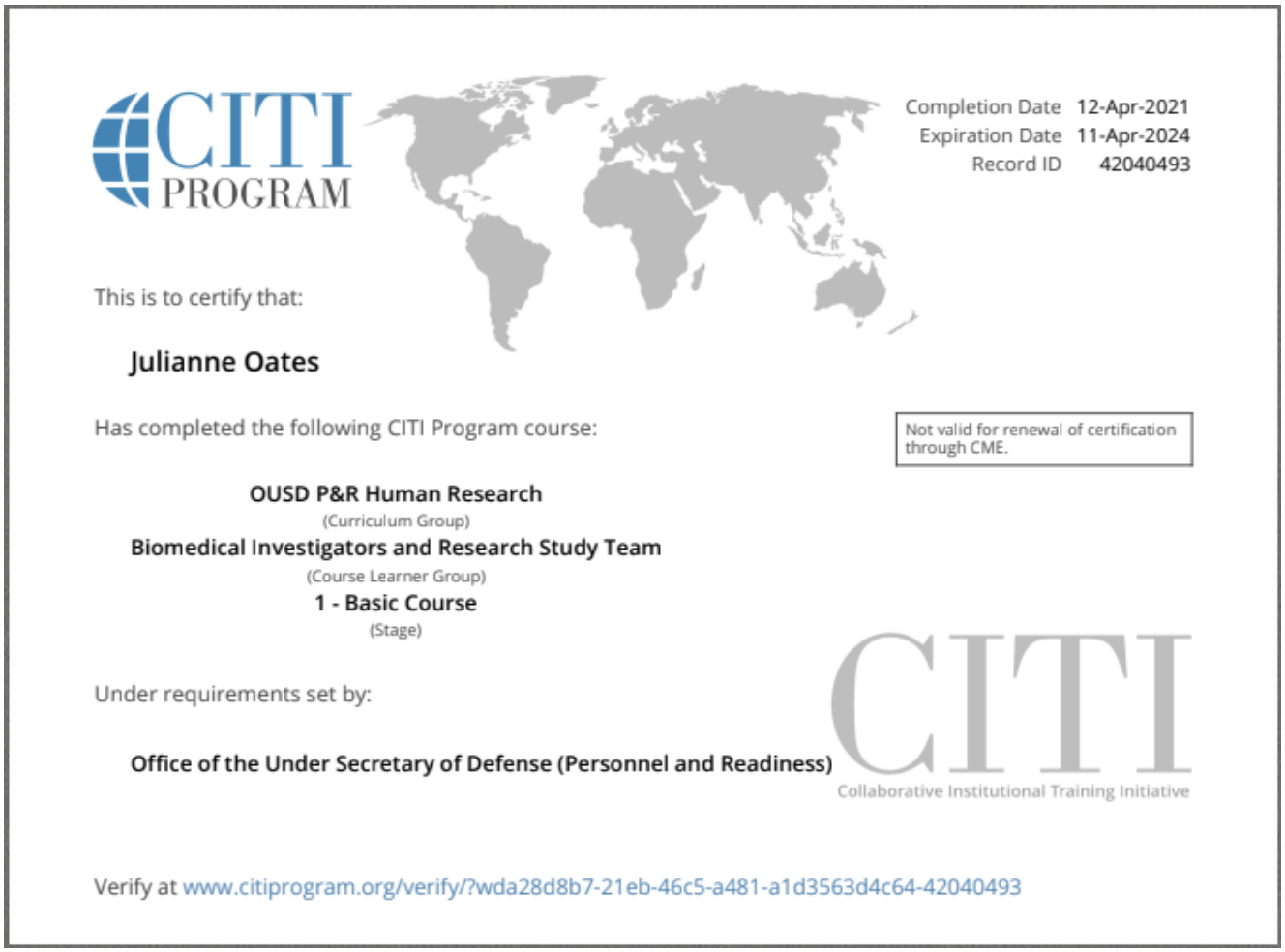
SENIOR MENTOR AGREEMENT STATEMENT:

I agree to serve as the **Senior Mentor** (Committee Chair) for the above DNP Student Project Team. As Senior Mentor, I agree to the duties and responsibilities outlined within the DNP Project Manual which include but are not limited to the provision of consultation and guidance supporting the entire DNP project journey and to ensure the DNP project is of sufficient rigor and demonstrates doctoral level scholarship to meet the requirements for USUHS GSN graduation.

Justin Hefley	HEFLEY.JUSTIN.BERYL.1286343534 Digitally signed by HEFLEY.JUSTIN.BERYL.1286343534 Date: 2023.01.21 20:40:51 -05'00'	01/20/2021
Senior Mentor (Chair) Name (typed)	*(signature)*	*(date)*

Form Version: 4 Sept 2016

Appendix J
CITI Certificates



CITI PROGRAM

Completion Date 12-Apr-2021
Expiration Date 11-Apr-2024
Record ID 42040493

This is to certify that:

Julianne Oates

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomedical Investigators and Research Study Team
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wda28d8b7-21eb-46c5-a481-a1d3563d4c64-42040493

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 12-Apr-2021
Expiration Date 11-Apr-2024
Record ID 42072807

This is to certify that:

Julianne Oates

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomed Research Coordinators, Clinical Coordinators, Study Coordinators & Research Administrators
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w5a0720b7-3267-4502-a407-1e27592d376d-42072807

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 12-Apr-2021
Expiration Date 11-Apr-2024
Record ID 42072561

This is to certify that:

Julianne Oates

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomedical Research Support Staff
(Course Learner Group)
1 - Basic Course
(Stage)

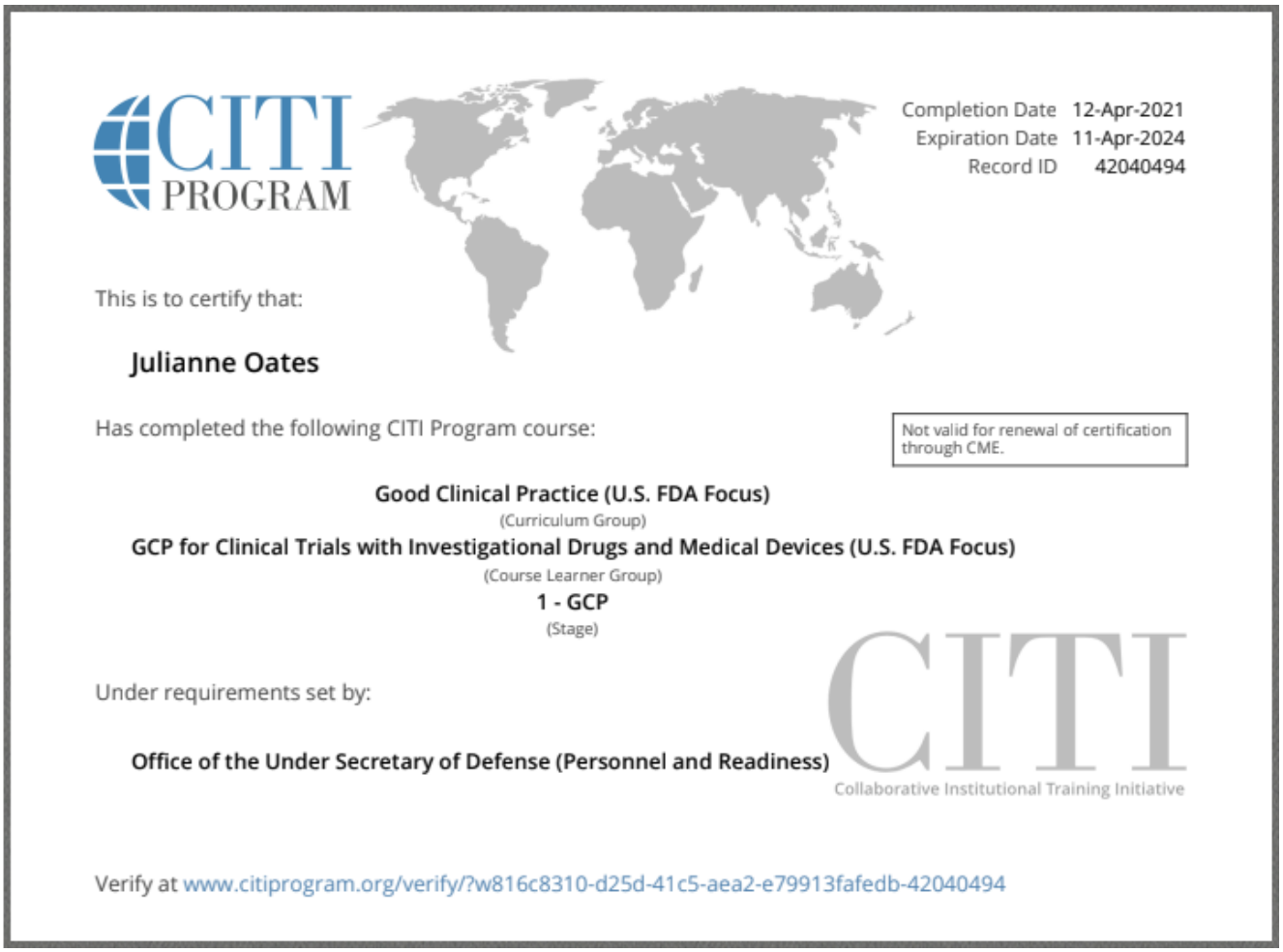
Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w5c3a4855-6d09-44ba-abd9-6ef3b5a76d2d-42072561

Appendix J
CITI Certificates



CITI PROGRAM

Completion Date 12-Apr-2021
Expiration Date 11-Apr-2024
Record ID 42040494

This is to certify that:

Julianne Oates

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Good Clinical Practice (U.S. FDA Focus)
(Curriculum Group)
GCP for Clinical Trials with Investigational Drugs and Medical Devices (U.S. FDA Focus)
(Course Learner Group)
1 - GCP
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w816c8310-d25d-41c5-aea2-e79913fafedb-42040494

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 17-Apr-2021
Expiration Date 16-Apr-2024
Record ID 42040496

This is to certify that:

Julianne Oates

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

GCP – Social and Behavioral Research Best Practices for Clinical Research
(Curriculum Group)
GCP – Social and Behavioral Research Best Practices for Clinical Research
(Course Learner Group)
1 - Basic Course
(Stage)

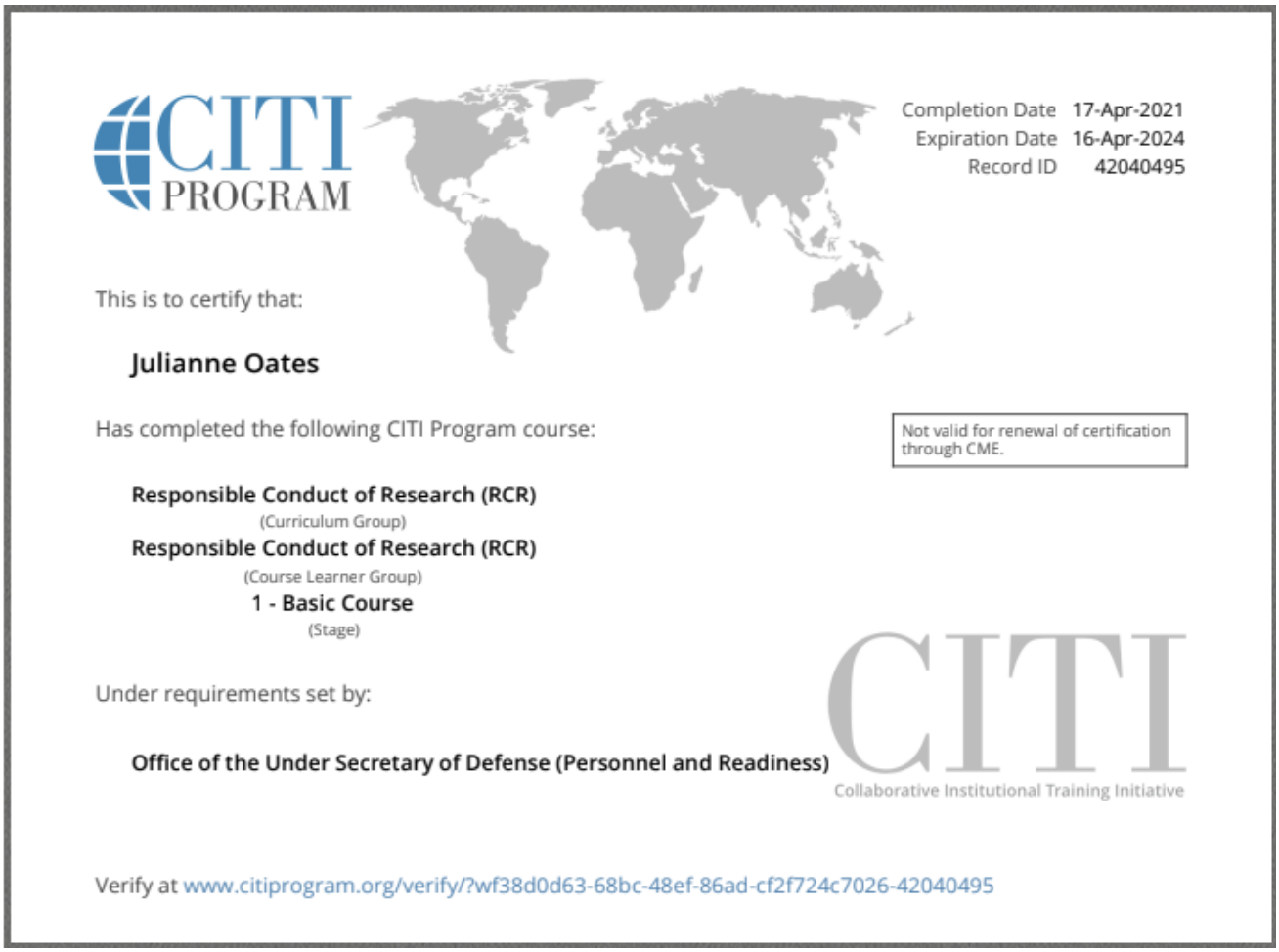
Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wc92455d3-79a0-403d-85cb-bf7fd7b3cc00-42040496

Appendix J
CITI Certificates



CITI PROGRAM

Completion Date 17-Apr-2021
Expiration Date 16-Apr-2024
Record ID 42040495

This is to certify that:

Julianne Oates

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Responsible Conduct of Research (RCR)
(Curriculum Group)
Responsible Conduct of Research (RCR)
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wf38d0d63-68bc-48ef-86ad-cf2f724c7026-42040495

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 13-Apr-2021
Expiration Date 12-Apr-2024
Record ID 42072806

This is to certify that:

Julianne Oates

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Social and Behavioral Investigators and Research Study Team
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w18ef7471-6d1d-4352-b1cf-c9b816e7c5bb-42072806

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 15-Apr-2021
Expiration Date 14-Apr-2024
Record ID 42110956

This is to certify that:

Randall Barlow

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomedical Investigators and Research Study Team
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?waa8333a8-d678-4f1b-b3d0-bfa649ac2fc8-42110956

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 15-Apr-2021
Expiration Date 14-Apr-2024
Record ID 42110989

This is to certify that:

Randall Barlow

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomed Research Coordinators, Clinical Coordinators, Study Coordinators & Research Administrators
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wfa869b68-2f41-426f-80ba-609876145080-42110989

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 15-Apr-2021
Expiration Date 14-Apr-2024
Record ID 42110988

This is to certify that:

Randall Barlow

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomedical Research Support Staff
(Course Learner Group)
1 - Basic Course
(Stage)

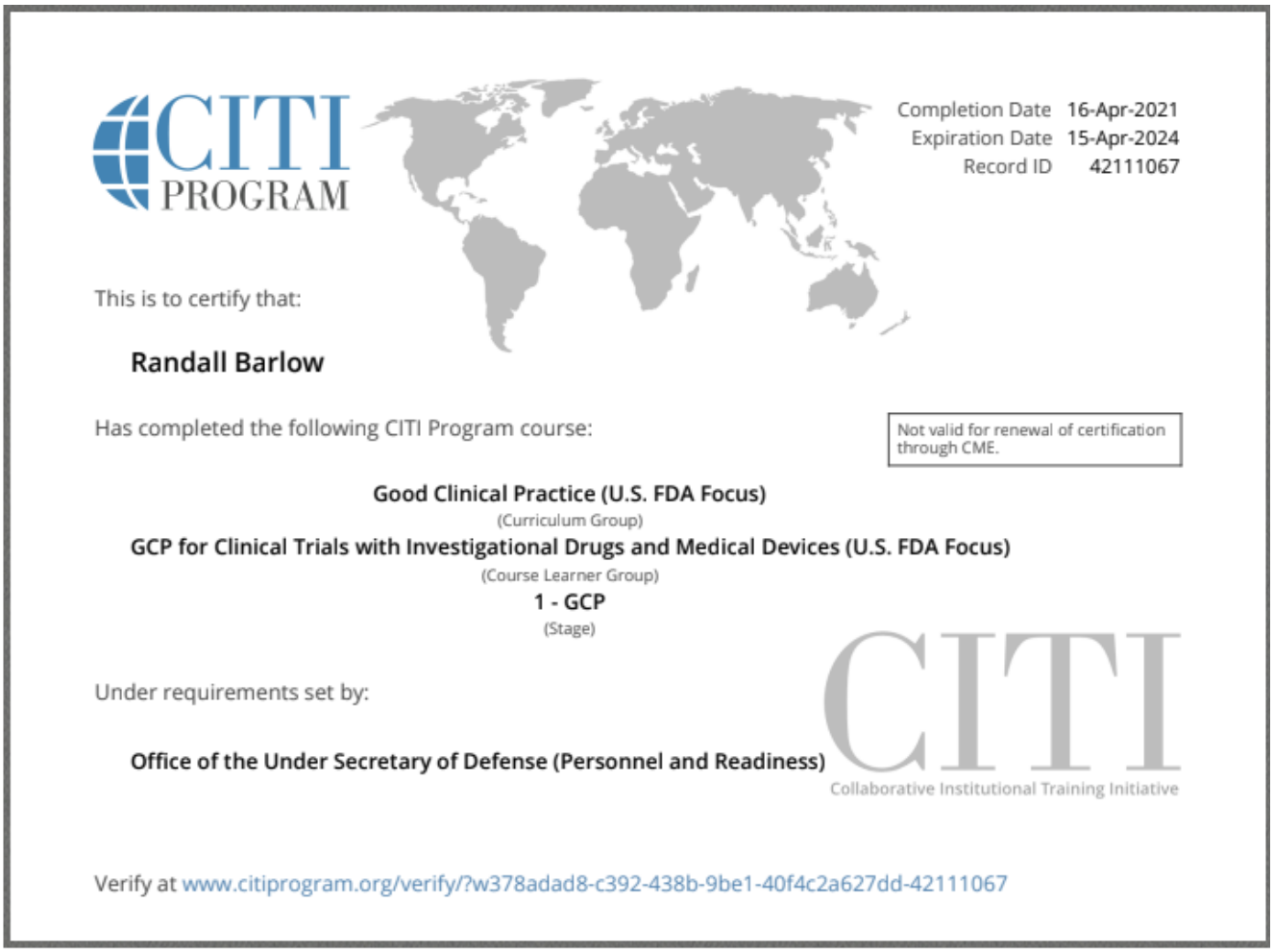
Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w5079f32b-ffd3-4395-a3a0-01aa7b365617-42110988

Appendix J
CITI Certificates



CITI PROGRAM

Completion Date 16-Apr-2021
Expiration Date 15-Apr-2024
Record ID 42111067

This is to certify that:

Randall Barlow

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Good Clinical Practice (U.S. FDA Focus)
(Curriculum Group)
GCP for Clinical Trials with Investigational Drugs and Medical Devices (U.S. FDA Focus)
(Course Learner Group)
1 - GCP
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w378adad8-c392-438b-9be1-40f4c2a627dd-42111067

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 16-Apr-2021
Expiration Date 15-Apr-2024
Record ID 42110991

This is to certify that:

Randall Barlow

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

GCP – Social and Behavioral Research Best Practices for Clinical Research
(Curriculum Group)
GCP – Social and Behavioral Research Best Practices for Clinical Research
(Course Learner Group)
1 - Basic Course
(Stage)

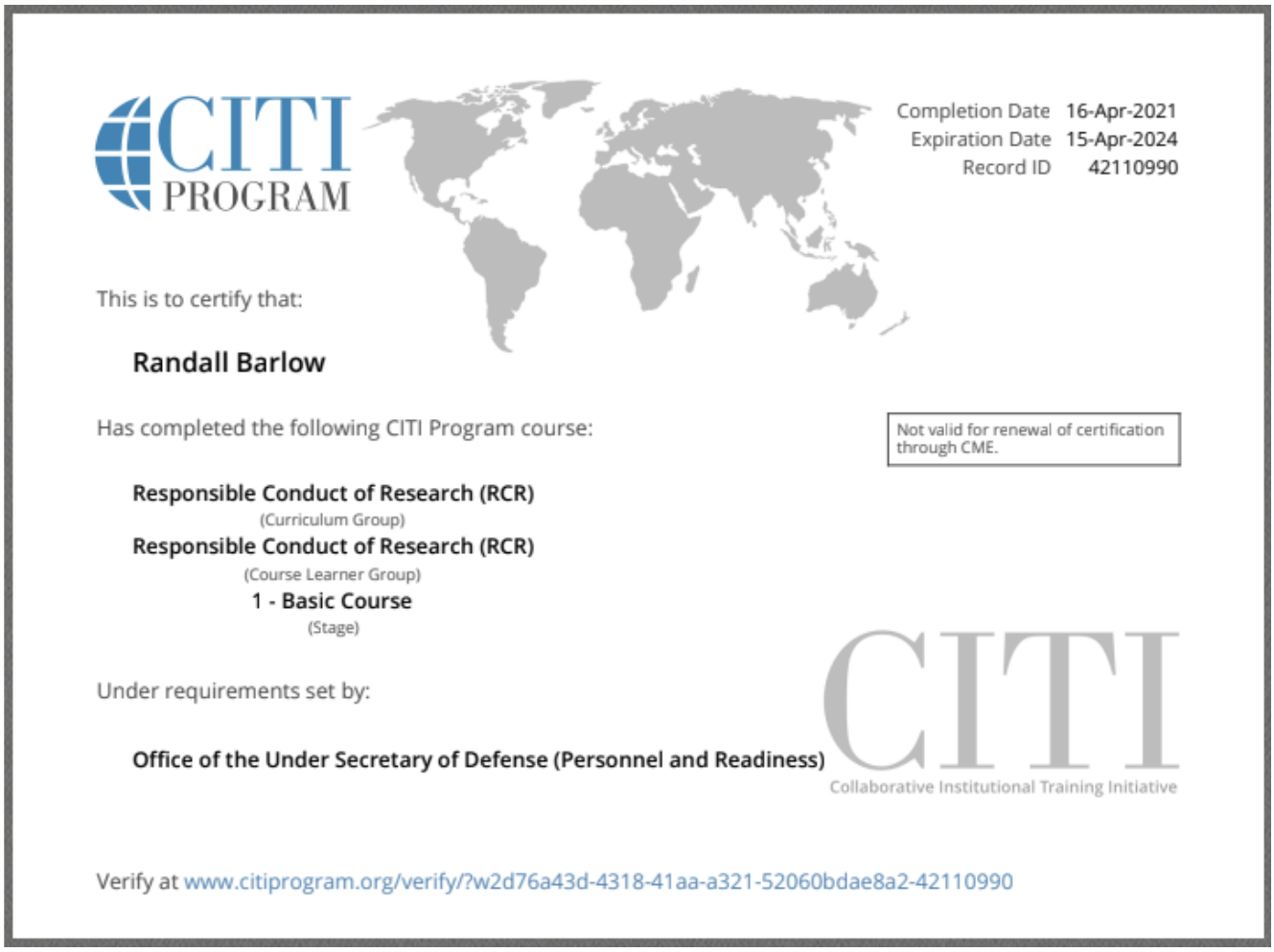
Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w85f66d58-7070-4be9-abc8-8f52a83b81dc-42110991

Appendix J
CITI Certificates



CITI PROGRAM

Completion Date 16-Apr-2021
Expiration Date 15-Apr-2024
Record ID 42110990

This is to certify that:

Randall Barlow

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Responsible Conduct of Research (RCR)
(Curriculum Group)
Responsible Conduct of Research (RCR)
(Course Learner Group)
1 - Basic Course
(Stage)

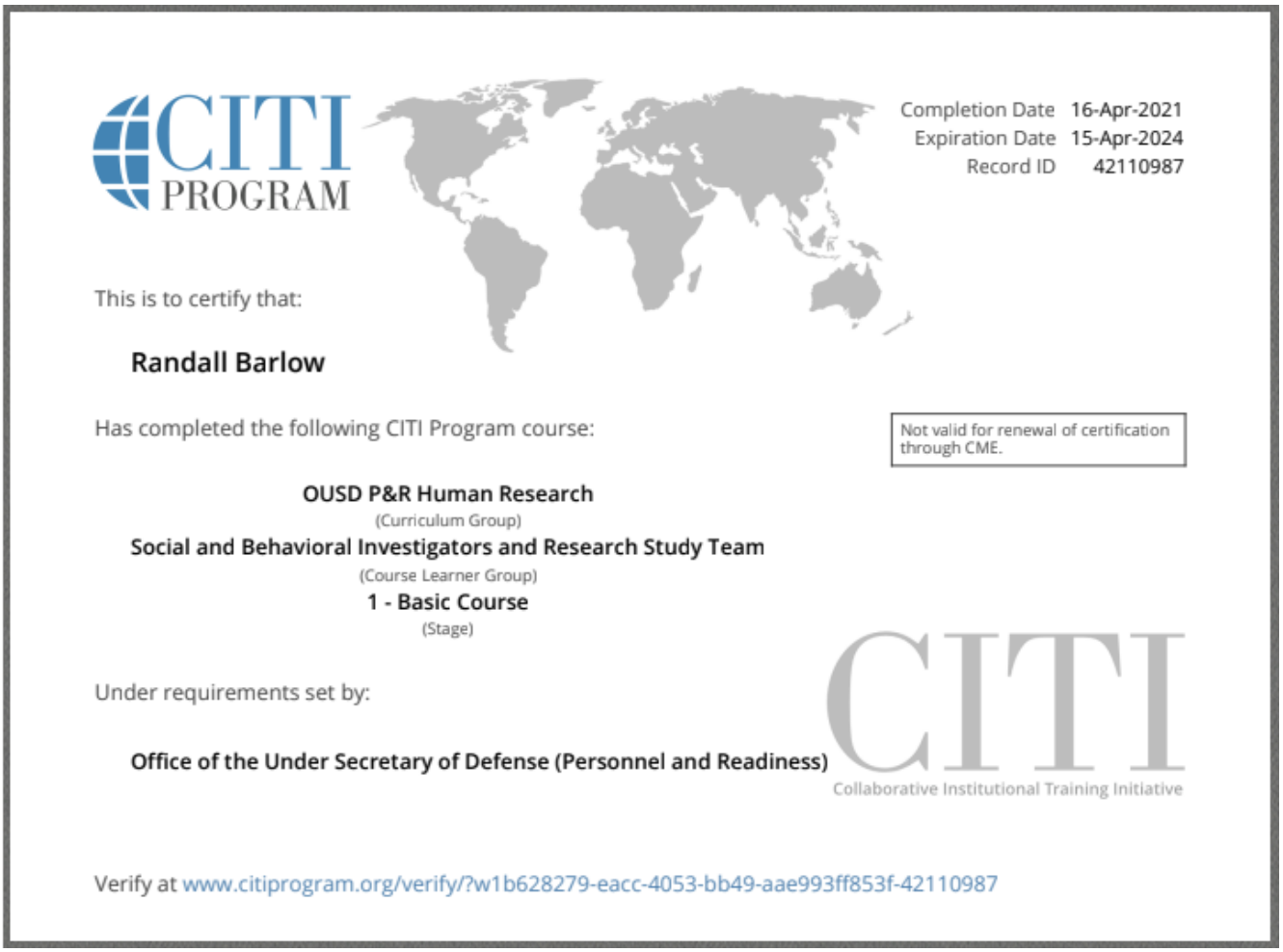
Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w2d76a43d-4318-41aa-a321-52060bdae8a2-42110990

Appendix J
CITI Certificates



CITI PROGRAM

Completion Date 16-Apr-2021
Expiration Date 15-Apr-2024
Record ID 42110987

This is to certify that:

Randall Barlow

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Social and Behavioral Investigators and Research Study Team
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w1b628279-eacc-4053-bb49-aae993ff853f-42110987

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 10-Apr-2021
Expiration Date 09-Apr-2024
Record ID 42016330

This is to certify that:

Stephen Duncan

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomedical Investigators and Research Study Team
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wcf72ba8e-94d1-4f70-893c-77c23038cd8a-42016330

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 14-Apr-2021
Expiration Date 13-Apr-2024
Record ID 42101553

This is to certify that:

Stephen Duncan

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomed Research Coordinators, Clinical Coordinators, Study Coordinators & Research Administrators
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wbae73943-3220-4eca-8a30-bcbb9ff371c9-42101553

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 14-Apr-2021
Expiration Date 13-Apr-2024
Record ID 42101552

This is to certify that:

Stephen Duncan

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Biomedical Research Support Staff
(Course Learner Group)
1 - Basic Course
(Stage)

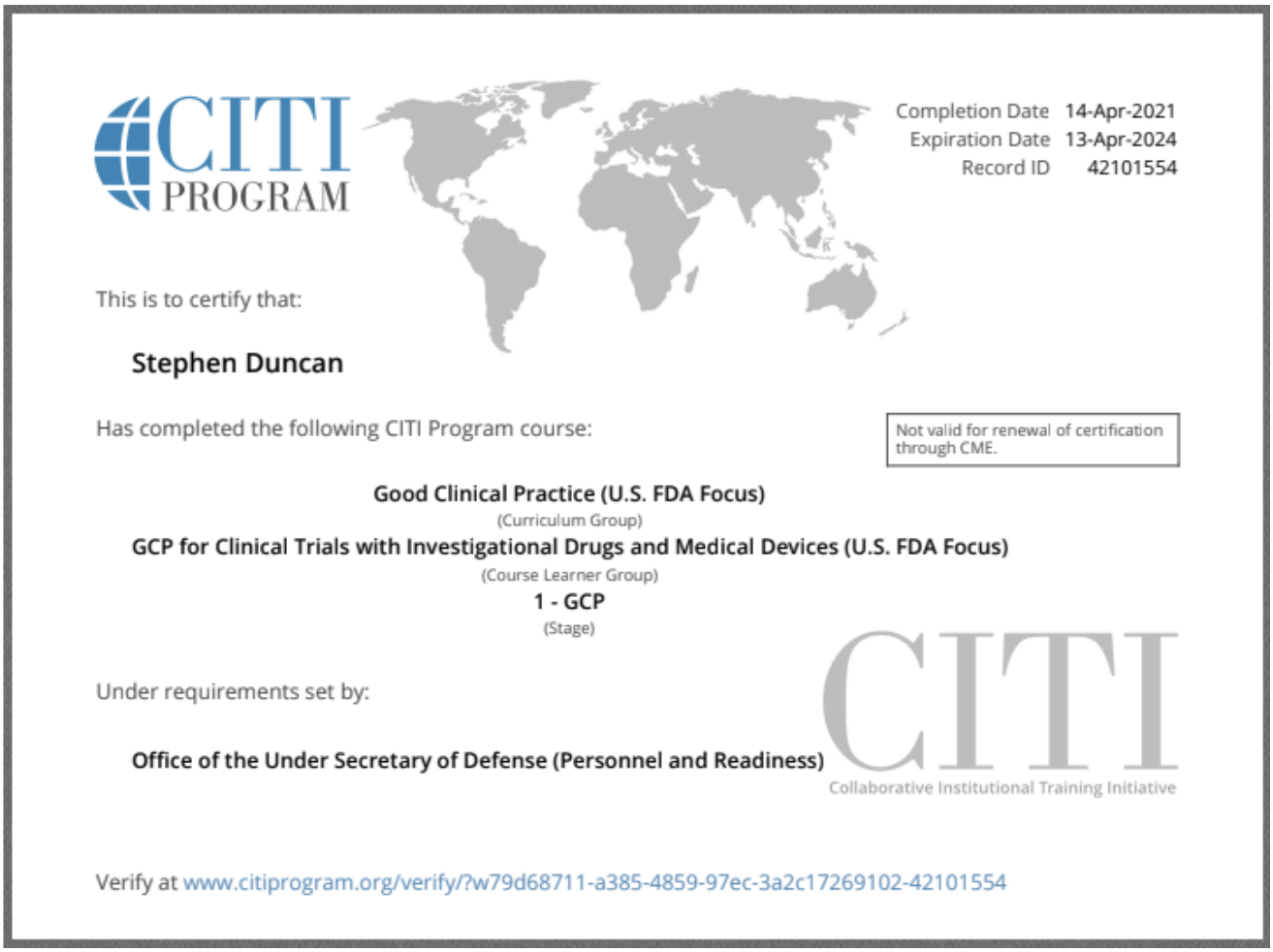
Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w60574ae0-4cb7-4109-b1ff-aaf8c1451a53-42101552

Appendix J
CITI Certificates



CITI PROGRAM

Completion Date 14-Apr-2021
Expiration Date 13-Apr-2024
Record ID 42101554

This is to certify that:

Stephen Duncan

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Good Clinical Practice (U.S. FDA Focus)
(Curriculum Group)
GCP for Clinical Trials with Investigational Drugs and Medical Devices (U.S. FDA Focus)
(Course Learner Group)
1 - GCP
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w79d68711-a385-4859-97ec-3a2c17269102-42101554

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 17-Apr-2021
Expiration Date 16-Apr-2024
Record ID 42101556

This is to certify that:

Stephen Duncan

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

GCP – Social and Behavioral Research Best Practices for Clinical Research
(Curriculum Group)
GCP – Social and Behavioral Research Best Practices for Clinical Research
(Course Learner Group)
1 - Basic Course
(Stage)

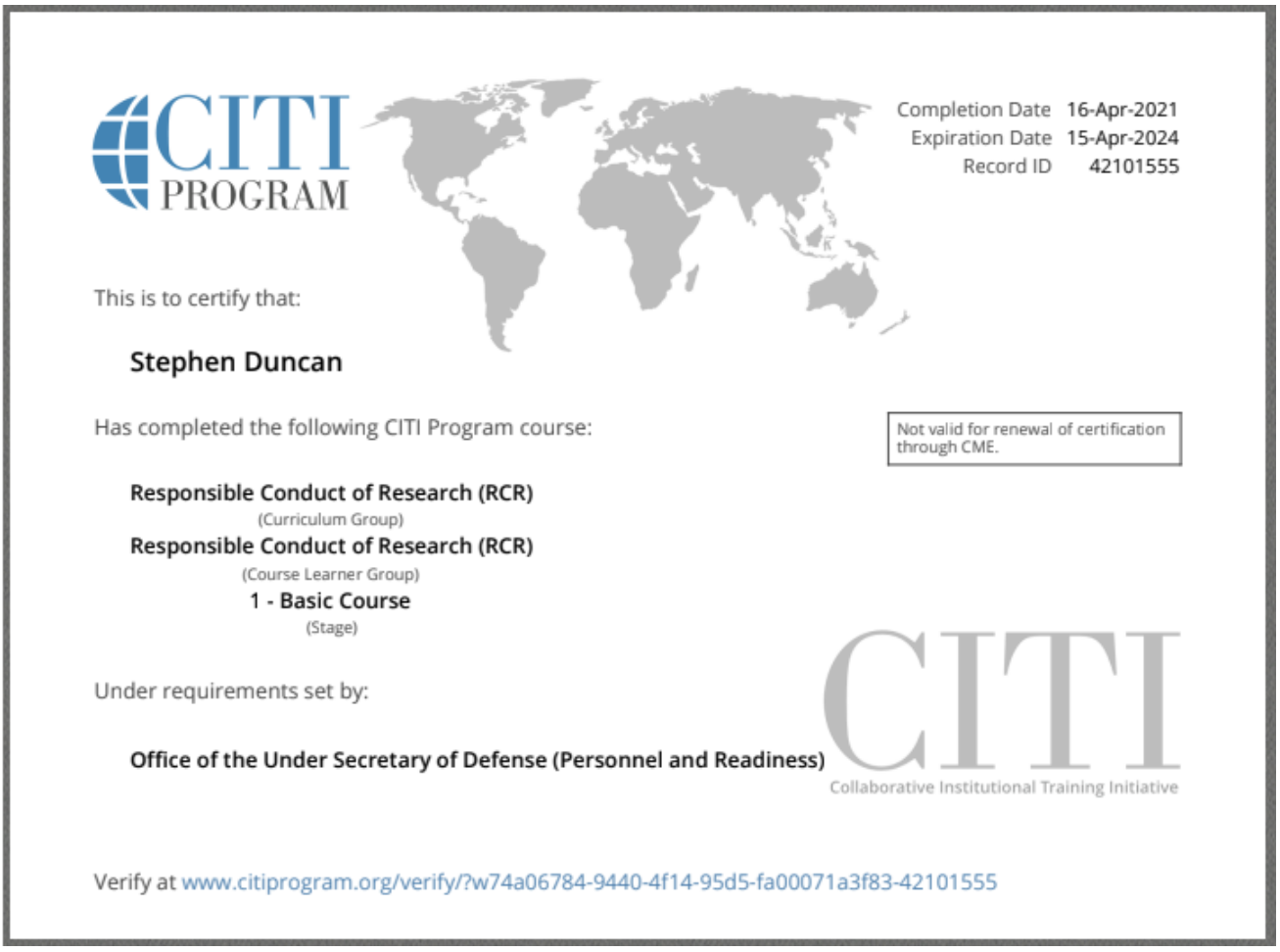
Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w63cdf505-8cbb-49a9-9445-e17d58ebfd66-42101556

Appendix J
CITI Certificates



CITI PROGRAM

Completion Date 16-Apr-2021
Expiration Date 15-Apr-2024
Record ID 42101555

This is to certify that:

Stephen Duncan

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Responsible Conduct of Research (RCR)
(Curriculum Group)
Responsible Conduct of Research (RCR)
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w74a06784-9440-4f14-95d5-fa00071a3f83-42101555

Appendix J
CITI Certificates

CITI PROGRAM

Completion Date 15-Apr-2021
Expiration Date 14-Apr-2024
Record ID 42101551

This is to certify that:

Stephen Duncan

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

OUSD P&R Human Research
(Curriculum Group)
Social and Behavioral Investigators and Research Study Team
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Office of the Under Secretary of Defense (Personnel and Readiness)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wf6cf38ff-4c49-452e-8c96-5c9f207805a4-42101551

Appendix K
USU (VPR) Form 3202N

USUHS FORM 3202N
DANIEL K. INOUYE GRADUATE SCHOOL OF NURSING
EVIDENCE-BASED PRACTICE/PERFORMANCE IMPROVEMENT PROPOSAL

VPR Date Stamp

Project Number: GSN-61-13074 (VPR will assign)

Project Title: **Identification of Emergency Airway Landmarks: Implementation of Ultrasound Training Among Perioperative Staff**

SECTION A: STUDENT POC INFORMATION

1. Name (Last, First, MI): **Oates, Julianne, R** Student E-mail: **julianne.oates@usuhs.edu**
2. Home Address: [redacted] Cell Number: [redacted]

SECTION B: COMMITTEE CHAIR / SENIOR MENTOR INFORMATION

3. Name (Last, First, MI): **Hefley, Justin, B**
4. Telephone: [redacted] Fax: E-mail: **justin.hefley@usuhs.edu**
5. USUHS Building/ Room No.:

SECTION C: PROJECT INFORMATION

6. Attach the Abstract for the proposal, including the following sections: Site Location of the Project, Title, Authors, Background or Problem/Issue, Clinical Question/Purpose, Project Design, Anticipated Organizational Impact/Implications for Practice and also include the Proposed Timeline. Single space the abstract and use Times New Roman font, size 12.
7. Is this proposal related to an active research project of the Chair/Senior Mentor identified in Section B? ☐ Yes ☒ No
   If yes, complete below; if no, proceed to Part 8.
   Project Number:
   Project Title:
   Project Start Date: Project End Date:
8. Anticipated period of performance: Project Start Date: **2/3/2022** Project End Date: **4/1/2022**
9. Performance Site(s): **Naval Medical Center Camp Lejeune, NC and Naval Hospital Jacksonville, FL**
10. Does this project involve any classified information? (Contact the USUHS Security Office for guidance) ☐ Yes ☒ No
11. Do you have a funding source for this project? ☐ Yes ☒ No ☐ NA
    If yes, specify the funding agency and the amount provided:

SECTION D: SIGNATURES

The following signatures attest to the validity of the above information:

OATES.JULIANNE.ROSE.1379402263 — Digitally signed by OATES.JULIANNE.ROSE.1379402263 Date: 2022.01.09 02:20:26 -05'00'
Student (Project Point of Contact for the Group) (Signature and Date)

HEFLEY.JUSTIN.BERYL.1286343534 — Digitally signed by HEFLEY.JUSTIN.BERYL.1286343534 Date: 2022.01.10 09:17:41 -05'00'
Chair/Senior Mentor (Signature and Date)

Chair/Program Director (Signature and Date)

BARBER.KENNETH.DOUGLAS.1177263644 — Digitally signed by BARBER.KENNETH.DOUGLAS.1177263644 Date: 2022.09.16 13:40:40 -04'00'
Chair/Program Director (Signature and Date)

DNP Project Director or PhD Director (Signature and Date)

Laura Taylor, PhD, RN, ANEF, FAAN — Digitally signed by Laura Taylor, PhD, RN, ANEF, FAAN Date: 2022.09.19 14:58:14 -04'00'
Associate Dean for Academic Affairs, GSN (Signature and Date)

SIMMONS.ANGELA.MARIE.1143313375 — Digitally signed by SIMMONS.ANGELA.MARIE.1143313375 Date: 2022.09.26 11:33:26 -04'00'
Associate Dean for Research, GSN (Signature and Date)

ROMANO.CAROL.A.1032050294 — Digitally signed by ROMANO.CAROL.A.1032050294 Date: 2022.09.26 17:28:33 -04'00'
Dean, DKI Graduate School of Nursing (Signature and Date)

In light of the above signatures, the project is approved.

WOODBERRY.MITCHELL.WAYNE.1060957114
USUHS Vice President for Research Date

USUHS Form 3202N (VPR) - Revised Sep 2015 v1.2
Previous versions are obsolete

Appendix L
MTF IRB / PI Letter of Determination

February 08, 2022

MEMORANDUM

From: Exempt Determination Official, Naval Medical Center Camp Lejeune
To: LCDR Justin Hefley, MC, USN

Subj: EXEMPT DETERMINATION OFFICIAL REVIEW

Ref: (a) NAVHOSPCAMLEJINST 6500.3B
(b) SECVAVINST 3900.39E
(c) 32 CFR 219

Encl: (1) EDO Determination Application

1. Per the reference, a review of your application, "*Identification of Emergency Airway Landmarks: Implementation of Ultrasound Training Among Perioperative Staff*," was completed by the Exempt Determination Official.

2. After reviewing your application, the project described does not meet the criteria of activities subject to federal regulations at 32 CFR 219. Based on the materials submitted, it has been determined that IRB oversight is not required at this time.

3. Although IRB oversight is not required, all activities proposed in the submission should be conducted in a responsible and ethical manner, and held to standards required by your field and your responsibilities at Naval Medical Center Camp Lejeune.

4. This determination applies only to the activities described in the determination submission and does not apply should any changes be made. If changes are being considered and there are questions about whether additional review is needed, please contact the HRPP.

5. If you have any questions or concerns, please contact CID at (910)450-3013 or stephanie.l.dysonelms.ctr@mail.mil.

V/r

[redacted]

Human Research Protection Program
Naval Medical Center Camp Lejeune

Appendix L
MTF IRB / PI Letter of Determination

DEPARTMENT OF THE NAVY
NAVAL HOSPITAL JACKSONVILLE
2080 CHILD STREET
JACKSONVILLE, FLORIDA 32214

10JAN22

MEMORANDUM FOR Director, Nurse Anesthesia Program, Chad Moore CDR, NC, USN

SUBJECT: NHJX ACCEPTANCE ON NMCCL INSTITUTIONAL REVIEW BOARD DETERMINATION MEMO

1. Research Project Details:

a. Title: "Identification of Emergency Airway Landmarks: Implementation of Ultrasound Training Among Perioperative Staff."

2. Naval Hospital Jacksonville Research Department accepts the signed memo from Naval Medical Center Camp Lejeune (NMCCL) indicating that IRB oversight is not required for this multi-site project. NHJX has confirmed with Mrs. Kersten Wheeler at NMCP that no other action is necessary.

3. POC for this action is Mr. Almer Mendoza, he can be reached at: [redacted]; Almer.B.Mendoza.CTR@mail.mil

[redacted]
James S. Feliz, LCDR, DC, USN
Research Director, Clinical Investigations Department
Naval Hospital Jacksonville

Appendix M
PAO Clearance / Level of Dissemination Classification

USU
Uniformed Services University

Oates, Julianne <julianne.oates@usuhs.edu>

Approval request for "NMCCL-NHJAX-2023-USU-PAO-Request documents.V3.24.2023.pdf"

USU Pub Clearance (via Google Workspace Approvals) <approvals-noreply@google.com> Tue, Apr 4, 2023 at 6:43 AM
Reply-To: approvals-noreply@google.com
To: julianne.oates@usuhs.edu

Approval Complete

U USU Pub Clearance (usupubclearance@usuhs.edu) approved the file

PDF NMCCL-NHJAX-2023-USU-PAO-

Open

Google Workspace

Google LLC, 1600 Amphitheatre Parkway, Mountain View, CA 94043, USA
You received this email because you are involved in an approval on a file in Google Drive.

Appendix N
DNP Project Completion Verification Form

Appendix G: Daniel K. Inouye Graduate School of Nursing
DNP Project Completion Verification Form

DOCTOR OF NURSING PRACTICE PROJECT
Completion Verification Form

The DNP Project titled:

Ultrasound Identification of the Cricothyroid Membrane: Accuracy, Speed, and Skill Retention After Rapid Training

was completed at: Naval Medical Center Camp Lejeune & Naval Hospital Jacksonville

by the following student(s):

(type student name)	*(signature)*	*(date)*
LCDR Julianne Oates	OATES.JULIANNE.ROSE.1379402263 Digitally signed by OATES.JULIANNE.ROSE.1379402263 Date: 2023.04.12 18:12:52 -04'00'	04/12/2023
LT Stephen Duncan	DUNCAN.STEPHEN.TIMOTHY.1299258820 Digitally signed by DUNCAN.STEPHEN.TIMOTHY.1299258820 Date: 2023.04.12 18:21:38 -04'00'	04/12/2023
LT Randall Barlow	BARLOW.RANDALL.JAMES.1267346514 Digitally signed by BARLOW.RANDALL.JAMES.1267346514 Date: 2023.04.13 09:08:54 -04'00'	04/12/2023

The DNP Practice Project Team verifies that the following components of the DNP project, accomplished by the above students, is of sufficient rigor and demonstrates doctoral level scholarship to meet the requirements for USUHS GSN graduation:

- Presentation of DNP project to the leadership/stakeholders at the Phase II Site,
- Abstract/Impact Statement (*Appendix F*), and
- DNP Project written report.

Verified by:

	(type name)	*(signature)*	*(date)*
Senior Mentor:	CDR Danielle Cuevas	CUEVAS.DANIELLE.KAY.1275198877 Digitally signed by CUEVAS.DANIELLE.KAY.1275198877 Date: 2023.04.13 15:32:12 -04'00'	4/12/2023
Team Mentor:			
Team Mentor:			
Phase II Site Director:	CDR Justin Hefley	HEFLEY.JUSTIN.BERYL.1286343534 Digitally signed by HEFLEY.JUSTIN.BERYL.1286343534 Date: 2023.04.12 17:50:45 -04'00'	4/12/2023

***For RNA Students only** - add the following additional signature for final verification of project completion:*

CDR Ken Barber	BARBER.KENNETH.DOUGLAS.1177263644 Digitally signed by BARBER.KENNETH.DOUGLAS.1177263644	24APR2023
RNA Project Director *(type name)*	*(Signature)*	*(Date)*

Form Version: 26 Aug 2017/30 Mar2020