Emergency Fresh Whole Blood Transfusion Training for Ukrainian Health Professionals in Austere Environments

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ABSTRACT

Background: Blood is a highly valuable medical resource that necessitates strict guidelines to ensure the safety and well-being of the recipient. Since the onset of the war in Ukraine there has been an increased demand for training in emergency fresh whole blood transfusion (EFWBT) to improve damage control resuscitation capabilities. To meet this demand, we developed, implemented, and evaluated a training program aimed at enhancing Ukrainian EFWBT proficiency. **Methods:** Eight Ukrainian healthcare professionals (UHPs), including six physicians and two medics, completed our training, derived from the Joint Trauma System Clinical Practice Guidelines, Tactical Combat Casualty Care (TCCC) Guidelines, 75th Ranger Regiment Ranger O-Low Titer (ROLO) program, and Marine Corps Valkyrie program. Participants were assessed on their confidence in the practical application and administrative oversight requirements of an EFWBT program. A cross-comparison was conducted between a larger data set of third-year medical students from the Uniformed Services University and the UHPs to determine the statistical significance of the program. **Results:** The difference in mean scores of UHPs during pre- and post-training was statistically significant ($p<.001$). Additionally, the average rate of improvement was greater for the UHPs compared with the third-year medical students ($p=.000065$). **Conclusion:** Our study revealed that the application of an EFWBT training program for UHPs can significantly increase confidence in their ability to conduct EFWBTs on the battlefield. Further larger-scale research is needed to determine the impact of this training on performance outcomes.

KEYWORDS: *Ukraine; fresh whole blood; transfusion medicine; emergency medical services; Russian-Ukrainian War*

Introduction

From 2014 to 2023, war in Ukraine has led to over 17,500 deaths and 125,000 casualties, and the conflict is still ongoing. Reducing patient mortality in this conflict can be achieved through the implementation and use of emergency fresh whole blood transfusion (EFWBT) programs.[1,2] These programs allow healthcare professionals to augment limited supplies of cold-stored low titer O whole blood (CS-LTOWB) through the use of low-titer group O blood donors, whose titer count is screened and vetted at a duration dependent on administrative policy. For elements operating far forward of optimal hospital care, as would be expected in a resource-limited, near-peer threat operating environment, low-titer group O blood donors are crucial for rapid-recall or immediate blood draw during routine combat operations.[3] Furthermore, administrative oversight of an EFWBT program is paramount in preventing adverse transfusion reactions, blood type incompatibilities, or relapse in EFWBT training.[4] Thus, clear administrative oversight and routine proficiency training in EFWBT procedures are necessary to ensure the success of the EFWBT program and increase the survivability rates of hemodynamically unstable patients.

Ukrainian casualties in isolated and resource-limited environments have limited means of expediting an immediate evacuation to a higher level of care.[5] Furthermore, Ukrainian healthcare professionals (UHPs) lack the logistical means to access a reliable supply of CS-LTOWB for their hemodynamically unstable patients.[5] To alleviate logistical constraints, it becomes evident that effective use, understanding, and implementation of an EFWBT protocol are paramount in improving the survivability of their patients. However, several challenges exist for the implementation of EFWBT within Ukraine.

Since the onset of the Russian invasion, Ukraine's healthcare system has continued functioning overall, but challenges such as the rising costs of managing medical resources, logistical obstacles, and damaged infrastructure are increasingly limiting access to essential services for both civilians and military personnel.[6] Ukraine's decentralized medical system has created a logistical lag in the appropriate distribution of medical supplies and equipment. These limitations are compounded by Russia's deliberate targeting of Ukrainian health infrastructure, with nearly 700 attacks on Ukrainian healthcare facilities to date, including hospitals, blood transfusion centers, pharmaceutical warehouses and factories, and ambulances, with 64 attacks on healthcare infrastructure in the first week of the current war in Ukraine alone.[7,8]

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With increasing casualty rates, limited access to FWB, and resource-intensive aspects of blood component therapy, it is increasingly imperative that UHPs possess sufficient experience and confidence in their EFWBT protocols, damage control resuscitation (DCR) training, and effective administrative oversight of walking blood banks (WBB).[9] However, transfusion training among UHPs is currently limited, as are their confidence levels with the use of blood and blood components, management of transfusion-related adverse events, and effective training pathways for evaluating competency in blood transfusion.[10] To close this training gap, the aim of this study was to develop and assess safe transfusion training for UHPs in order to equip them with the confidence to effectively employ an emergency blood transfusion protocol in the event of a mass casualty incident (MCI).

Methods

Training Participants

The participants in our study were eight UHPs from various medical backgrounds, including a pediatrician, an infectious disease specialist, two general surgeons, an anesthesiologist, and a pathologist, each of whom had accumulated 13–21 years of experience in their respective disciplines before redirecting their efforts to training Ukrainian medics in Tactical Combat Casualty Care (TCCC). Two of the providers serving as medics embedded within the Ukrainian medical team did not have previous medical experience before the Russian invasion; one medic had a career in engineering and was a construction manager, while the other was a railway manager. The UHPs visited the Uniformed Services University of the Health Sciences (USU) in Spring 2023 for training in clinical and military operational medical skills, during which they completed our EFWBT training initially designed for third-year medical students.

Training Development

Our research team assembled a panel of experts in blood transfusion and DCR to develop an EFWBT program aimed at improving transfusion capabilities for future generations of military physicians on the battlefield. This panel of experts included two board-certified emergency medicine physicians, an Army Special Operations Combat Medic, a Special Forces Medical Sergeant, a Navy Special Operations Independent Duty Corpsman, two Navy Fleet Marine Force Corpsmen, and a Ph.D. curriculum researcher. This panel used the modified Delphi technique to identify key aspects of EFWBT necessary for effective administration and oversight of combat blood transfusions. The research team then developed a stepwise EFWBT assessment and didactics utilizing the guidelines and recommendations of the Joint Trauma System Clinical Practice Guideline (JTS-CPG) for Prehospital Blood Transfusion,[11] the JTS-CPG for Whole Blood Transfusion,[12] the JTS-CPG for Damage Control Resuscitation,[13] the JTS-CPG for Damage Control Resuscitation in Prolonged Field Care,[14] the Tactical Combat Casualty Care Guidelines,[15] the 75th Ranger Regiment Ranger O-Low Titer (ROLO) Program,[16] and the Marine Corps Valkyrie program (Matthews K, unpublished data).[17]

Training Implementation

Prior to the start of training, UHPs conducted a self-reported questionnaire used to determine their pre-training confidence level in EFWBT procedures (Figure S3). The self-assessment was cross-examined using a post-training self-reported questionnaire to determine whether their confidence level increased. Next, a 25-minute didactic presentation was led by a multiservice medical team consisting of an Army Special Operations Combat Medic, a Navy Special Operations Independent Duty Corpsman, and an Army Special Forces Medical Sergeant. The presentation outlined all relevant transfusion procedures from donor collection to transfusion of FWB, utilizing donor collection and patient transfusion equipment used during the latter practical-application phase (Appendixes A and B [Matthews et al.]).

The donor collection and transfusion equipment consisted of a low-titer group O donor list, assessment rubric (Figure S2), and donor/recipient transfusion supplies (Figure 1). The didactics were followed by a hands-on demonstration of the EFWBT procedure led by the multi-service medical team. The didactics covered the assessment of ABO- and Rhesus-systems blood type matching using EldonCards, assessment of donor baseline vitals, inspection of collection and transfusion equipment, recipient indications for blood transfusion, identification of blood transfusion reactions and treatments rendered, and proper procedures for blood collection and transfusion at point of injury (Figures 1–4 and Appendixes A and B [Matthews et al.]).

FIGURE 1 *Emergency fresh whole blood transfusion medical training equipment. (Photo credit: Joshua Cuestas)*

UHPs then engaged in supervised self-guided practice to assess and resolve knowledge gaps in EFWBT procedures and protocols. Then, adhering to a 1:1 instructor-to-student ratio, the multiservice medical team evaluated each UHP on the application of EFWBT, starting with donor collection to transfusion of FWB using the assessment rubric (Figure S2). UHPs then conducted the post-training self-reported assessment to evaluate confidence levels. Only the pre- and post-training self-assessment were retained for evaluation of improved confidence in EFWBT techniques and procedures.

Training Evaluation

Evaluation of UHP confidence was conducted by cross-examining pre- and post-training self-reported assessments to determine whether the EFWBT training program effectively increased UHP-perceived confidence levels (Figure S3). The questionnaire consisted of six Likert-style questions with answer scores ranging from 1 to 5 (1 = not confident at all, 2 = slightly confident, 3 = somewhat confident, 4 = fairly confident, 5 = completely confident) (Figure S3). Because of the

FIGURE 2 *Ukrainian healthcare professionals inspect donor collection equipment. (Photo credit: Tom Balfour)*

FIGURE 3 *Ukrainian healthcare professionals observe emergency fresh whole blood transfusion procedures. (Photo credit: Tom Balfour)*

FIGURE 4 *Ukrainian healthcare professionals conduct guided emergency fresh whole blood transfusion procedures. (Photo credit: Tom Balfour)*

small sample population of UHPs, the pre- and post-training self-assessments were compared to the pre- and post-training self-assessments of third-year medical students from the USU to determine the statistical relevance of the results; the third-year medical students completed the same whole blood transfusion training as the UHPs.

Results

Ukrainian EFWBT Assessment

Our results revealed a strong trend in increased UHP confidence at a rate equal to that of the third-year medical students. Prior to the training, no participants rated themselves as 'fairly confident' or 'completely confident' in their ability to teach an EFWBT course or to perform an EFWBT in an austere environment. After the training, scores increased significantly; 75% of the participants felt 'fairly confident' or 'completely confident' they could teach an EFWBT course, and 87.5% of the participants rated themselves as 'fairly confident' or 'completely confident' in their ability to perform an EFWBT in an austere environment. The difference between both pre- and post-training self-assessments was evaluated and found to be statistically significant (p<.0001) (Figure 5). Additionally, during the pre-training self-assessment, 60% of all participants rated themselves as at least 'fairly confident' in their ability to identify and determine the appropriate treatment for adverse FWB transfusion reactions, whereas in the post-training self-assessment, 91% of all participants rated themselves at least 'fairly confident' (Table 1).

FIGURE 5 *Overall confidence of medical students and Ukrainian trainees.*

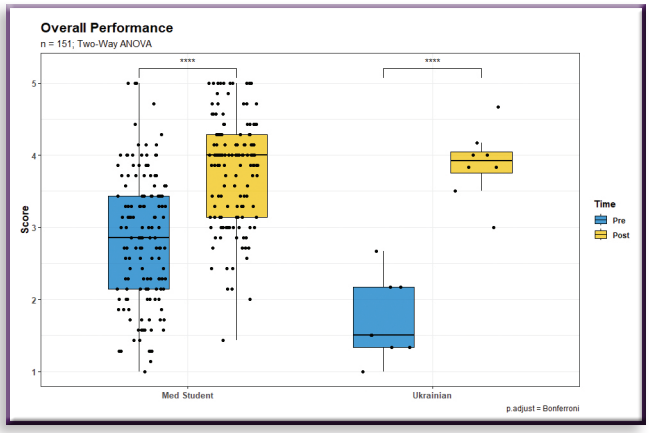


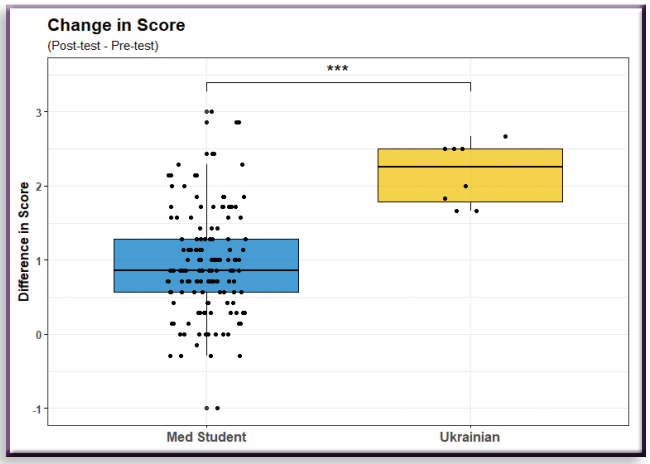
TABLE 1 *Ukrainian Healthcare Professional Emergency Fresh Whole Blood Transfusion (EFWBT) Confidence Increase*

Question	Pre	Post
Teaching EFWBT	0% (0/8)	75% (6/8)
Performing EFWBT	0% (0/8)	87.5% (7/8)

We then compared the overall performance of the UHPs to a larger sample of third-year medical students; 95% CIs indicate that third-year medical students entered the training with more confidence in practical EFWBT knowledge and administrative oversight than UHPs (Figure 6). However, by the end of the training, both groups were equally confident in practical EFWBT knowledge and administrative oversight (p<.001). The mean baseline score of the pre-training self-assessment for UHPs and third-year medical students was 34.17% and 58.25%, respectively, while the post-training self-assessment increase for Ukrainian and third-year medical students was 77.50% and 77.74%, respectively. The difference between the mean scores was calculated using a paired-sample t test to compare the pre- and post-assessment questionnaires and was found to be statistically significant (two-tailed p-value <.0001).

The pre- and post-training self-assessments for UHPs and third-year medical students were then subjected to a two-way

FIGURE 6 *Change in medical students and Ukrainian trainees' confidence.*



ANOVA with an estimated marginal means post hoc analysis and Bonferroni correction, and the differences in scores between the two population sets were analyzed using a Wilcoxon-Mann-Whitney *U* test.

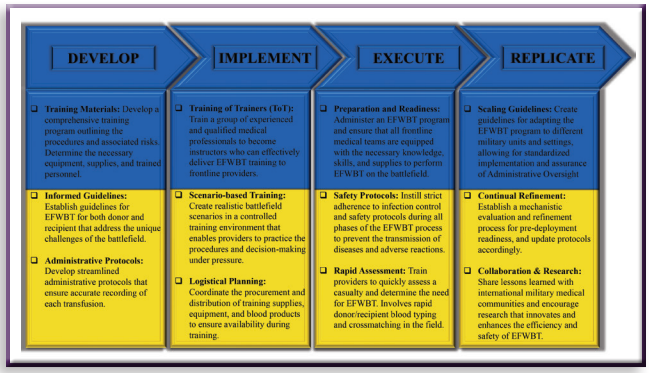
These results revealed a statistically significant *p*-value of <.05 (α=0.05) (Appendix C). The pre- and post-training self-assessment median latencies of the UHPs and third-year medical students differed significantly; the data suggest a larger mean change in scores for the UHPs (*p*=.000065) (Figure 6). The results of this study revealed that EFWBT training can significantly improve confidence in EFWBT for UHPs, setting the foundation for continued research and development in improving EFWBT training protocols on a global scale.

Discussion

Our study provides a novel look at determining the value of an EFWBT training program for UHPs and offers a foundation to promulgate ongoing research and foster international collaboration. The Russia-Ukraine War has recently spurred a wealth of research in capability assessments of Ukrainian medical systems, but there still remains a demand to resolve these multifaceted healthcare disparities.[18] Furthermore, there is little to no research that offers a holistic understanding of the current capabilities of front-line UHPs proficiency in DCR. Continued research would not only increase our understanding of disparities in Ukrainian medical training but also offer invaluable insight for effectively managing EFWBT requirements for U.S. Military assets in resource-limited, near-peer threat environments. In order to garner a better understanding of these requirements, future U.S. Military collaboration with international partners and industry experts is paramount. Collaboration in EFWBT will not only improve DCR capabilities but also aid in determining the unique logistical requirements that exist when operating in resource-limited, near-peer threat environments, far-forward of traditional hospital care. Comparatively, there is limited accessibility to FWB and limited proficiency in EFWBT training in Ukraine; this systematically contributes to the disparity in effectively treating patients on the battlefield.[19]

To resolve these limitations, our research team established a curriculum that assessed the confidence of UHPs in the application of managing an EFWBT program; this program serves as a pilot for replicating EFWBT programs and resolving training disparities in DCR (Figure 7). Training disparities pose a potential threat to patient safety and can result in potentially fatal acute hemolytic transfusion reactions. EFWBT program oversight requires a curriculum that encompasses training for all levels of medical practice, from physicians to advanced first responders, in both hospital and prehospital transport settings.[20] Our training program addresses these disparities and makes meaningful contributions to increasing UHPs capabilities by developing an EFWBT program that can be replicated at scale in resource-restrictive operating environments while drastically reducing preventable deaths, simultaneously increasing the safety and effectiveness of blood transfusions.

FIGURE 7 *The way forward for emergency fresh whole blood transfusion (EFWBT) training programs.*



A foundational step in implementing this program is the organization of a dedicated EFWBT team equipped with necessary transfusion supplies and a keen understanding of transfusion medicine.[21] Identifying and training EFWBT instructors and administrators, particularly medics and healthcare providers, are essential for delivering consistent, high-quality training and ensuring safe EFWBT practices in emergency situations. This team should adhere to strict guidelines for maintaining training requirements, donor testing, and tracking blood donor/transfusion supply inventory to ensure the highest quality of medical training. The EFWBT program and curriculum must cater to the specific requirements of the operating environment, and strict administration oversight is crucial in ensuring the safety of both the donors and recipients. The EFWBT program should be designed to educate participants on proper transfusion procedures and safety protocols such as requisition of medical supplies, handling and storage of equipment, donor screening and data storage, indications for EFWBT, preparation and inspection of donor/recipient transfusion equipment, identification of transfusion reactions and treatments rendered, and concise guidelines on EFWBT.

Additionally, UHPs in the hospital setting and involved in prehospital transport should maintain proficiency in EFWBT to ensure a consistent supply of EFWB in the event of MCIs by developing protocols for screening, testing, and selecting potential blood donors to ensure donor suitability and safety.[22] Collaboration with each tier of patient care, from point of injury to long-term patient care, expands the resource pool and enhances the program's ability to meet the demand for FWB in resource-restrictive environments. Implementing an EFWBT program on a larger scale requires careful planning, coordination, and adherence to regulatory guidelines to improve emergency medical response, enhance survivability, and reduce mortality rates.[23] Furthermore, periodic training in EFWBT at every level of patient care refines medical skill sets, identifies

the requirements of continued education and training, and necessitates the requirement for effective administrative oversight to prevent undesirable patient outcomes.

Through international collaboration, the U.S. Military and UHPs can enhance EFWBT awareness and training, reducing mortality rates for patients in austere operating environments.[24] Implementing a Ukrainian EFWBT program on a larger scale requires careful planning, coordination, and adherence to regulatory guidelines to improve emergency medical response, enhance patient survivability, and reduce mortality rates in conflict zones. By clearly outlining objectives, the program can set a clear direction for the implementation efforts of medical professionals, military leaders, logistical experts, and regulatory representatives to ensure effective oversight and coordination. This multidisciplinary approach ensures that the EFWBT program benefits from the expertise and perspectives of various stakeholders by enabling a comprehensive and integrated implementation strategy.

Furthermore, collaboration between U.S. Military healthcare professionals and experts in transfusion medicine can improve developmental strategies and EFWBT guidelines, with the aim of ensuring safety, quality control, and compliance with regulatory guidelines. EFWBT guidelines should define standardized protocols to ensure consistent and safe practices, periodic proficiency training requirements, and clear administrative guidance in WBB protocols. Effective collaboration and a multifaceted approach toward improving patient outcomes will not only save lives but continue to refine and develop transfusion practices on the battlefield.

Limitations

Limitations in resource acquisition, language barriers between instructors and participants, and participant prior medical training may have adversely impacted training outcomes. The testing conditions for the EFWBT course involved the use of a simulated arm/IV trainer, which could degrade the efficacy of training in real-world applications. Autologous blood transfusions and assessment of skill proficiency should be incorporated in high-fidelity simulated TCCC patient scenarios to provide a more accurate assessment of the capabilities of medical providers in treating real-world casualties. Another limitation of our study was the language barrier between instructors and Ukrainian participants. Since the EFWBT program was taught in English, which was the Ukrainian participants' second language, the duration of didactics and hands-on EFWBT training was expanded to allow for adequate translation of certain topics. Presentations, training materials, and assessments translated into the participants' native language may bridge the language barrier between instructors and participants. Furthermore, when comparing the UHPs to third-year medical students, the program may have had more of an impact on the UHPs based on the limited exposure to prior experiences in transfusion medicine.

Future Research

A longitudinal cohort study of Ukrainian participants should be conducted to assess the long-term effects and administrative oversight of Ukrainian EFWBT programs and the development of concurrent Ukrainian EFWBT programs. Moreover, research evaluating enduring Ukrainian EFWBT program capabilities should be assessed to determine whether UHPs trained in a Ukrainian-specific EFWBT program are able to retain long-term confidence and competence in EFWBT. Future research should evaluate the differences in performing autologous EFWBT versus simulated arm/IV trainers to determine whether autologous blood transfusions replicate real-world applications. This is paramount in ensuring the validity of this research in assessing participants' performance of DCR for hemodynamically unstable patients in simulated combat conditions and the assessment of whether IV trainers create disparities in confidence or competence in EFWBT training.

Conclusion

Our results demonstrated that the application of a Ukrainian EFWBT training program can significantly increase UHPs' confidence in conducting EFWBTs. Further larger-scale research is required to determine the impact of this training on concurrent performance outcomes. EFWBT has the potential to be a critical lifesaving capability in near-peer threat environments and resource-restricted settings. However, its successful implementation requires ongoing research, collaboration, and training to optimize its impact on patient outcomes.

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Author Contributions

ZLB wrote the manuscript; developed the curriculum, training, and evaluation of EFWBT trainees; and developed the data for Figure 7. JPC contributed to the Limitations section and Discussion section of the manuscript; developed the curriculum, training, and evaluation of EFWBT trainees; and developed the data for Figure 1. KJM contributed to the Training Development section; developed the curriculum, training, and evaluation of EFWBT trainees; and developed the data for Appendices A and B. JTS contributed to the Training Participants section of the manuscript. DWM developed the data for Figures 5 and 6 and contributed to the Results section of the manuscript. RC agreed to evaluate all aspects of the work ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved.

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Disclaimer

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APPENDIX A LEARNING MODULES

Module	Learning Objectives
Didactic lecture day presentation	1. Discuss the advantages of fresh whole blood in DCR. 2. Discuss current models of emergency fresh whole blood transfusion training. 3. Identify the indications to initiate a point of injury emergency fresh whole blood transfusion. 4. Discuss screening criteria of potential blood donors. 5. Perform appropriate steps for collection and transfusion of emergency fresh whole blood. 6. Monitor a patient for adverse transfusion reactions. 7. Identify medications used in the management of a patient in hemorrhagic shock.
Indications for EFWBT	1. Identify benefits of FWB compared to crystalloids. 2. Identify stages and presentation of hemorrhagic shock. 3. Identify injury patterns associated with hemorrhagic shock. 4. Identify measures of adequate resuscitation.
Transfusion procedures	1. Components of an emergency blood transfusion kit. 2. Procedures for use of collection and administration equipment. 3. Use of EFWBT in the treatment algorithm of patients experiencing hemorrhagic shock.
Collection and transfusion	1. Proper use of collection equipment. 2. Collection site disinfection using aseptic technique. 3. Desirable sites of venipuncture. 4. Collection process. 5. Visual inspection of donated blood. 6. Potential donor reactions that may occur during blood donation. 7. Donor after care and restrictions. 8. Blood handling, labeling, and disposal.
Monitoring the post-transfusion patient	1. Guidelines for monitoring a post-transfusion patient. 2. Potential reactions that may occur during blood donation. 3. Identifying and treating transfusion-related adverse reactions.

DCR = damage control resuscitation; EFWBT = emergency fresh whole blood transfusion.
Source: Matthews K, unpublished data.

APPENDIX B SKILLS STATIONS

Skills Stations	Description
EFWB Transfusion demonstration and practical application	1. Students will state the indications for EFWBT, identify their prescreened donor appropriately and collect a simulated unit of fresh whole blood. 2. Students will then gain vascular access on a simulated patient and appropriately administer the simulated unit of fresh whole blood.
Vital signs monitoring and charting	1. Students will take a full set of vital signs (pulse, respirations, blood pressure, SpO_2, mental status, Glasgow Coma Scale score) on a partner and chart them appropriately on the modified DD 1380. 2. Students will then receive a verbal patient report in the ZMIST format and appropriately transcribe onto the DD 1380. 3. Students will chart given vital signs onto the DD 1380, identify vital signs trends, and classify the patient as a responder, transient responder, or non-responder.
Medication administration	1. Students will be able to correctly identify the dosages, uses, routes of administration, and contraindications for the following medications used in the treatment of a patient in hemorrhagic shock: a. Tranexamic acid b. Calcium gluconate c. Ketamine
Donor screening	Students will be presented with four simulated donor narratives annotated on their respective ASBP 572-EWB and discuss in small groups, under the guidance of an instructor, their considerations for donor selection based on the established donor criteria and disqualifying conditions.

EFWBT = emergency fresh whole blood transfusion; SpO_2 = oxygen saturation as measured by pulse oximetry; ZMIST = Zap number, mechanism of injury, injuries sustained, signs and symptoms, treatments.

APPENDIX C PRE- AND POST-ASSESSMENT QUESTIONAIRE

Pre/Post Questionnaire

I can perform an emergency fresh whole blood transfusion safely without direct supervision or assistance from another medical provider.

1-not confident at all 2-slightly confident 3-somewhat confident 4-fairly confident 5-completely confident

I can perform an emergency fresh whole blood transfusion in a field environment.

1-not confident at all 2-slightly confident 3-somewhat confident 4-fairly confident 5-completely confident

I can identify signs and symptoms of adverse reactions associated with fresh whole blood transfusions and initiate the proper treatment.

1-not confident at all 2-slightly confident 3-somewhat confident 4-fairly confident 5-completely confident

I can teach medics how to perform an emergency fresh whole blood transfusion.

1-not confident at all 2-slightly confident 3-somewhat confident 4-fairly confident 5-completely confident

I can plan and execute a Walking Blood Bank.

1-not confident at all 2-slightly confident 3-somewhat confident 4-fairly confident 5-completely confident

I can find resources about performing whole blood transfusions in a field environment.

1-not confident at all 2-slightly confident 3-somewhat confident 4-fairly confident 5-completely confident

FIGURE S2 *Ukrainian emergency fresh whole blood transfusion (EFWBT) assessment rubric.*

Operation Gunpowder Blood Transfusion Assessment

Student name: _____ Group/Platoon: _____ Evaluator name: _____ Date: _____

Skills Assessment Checklist for Emergency Fresh Whole Blood Transfusion C = critical failure worth 2 points, each other step worth 1 point			
1. Donor Collection. Evaluator starts time: _____ (MM:SS)	**C**	**P**	**F**
a. Student verbalizes activation of the walking blood bank and states ALL indications for initiating blood transfusion: ☐ Penetrating trauma to chest abdomen, or junctional areas ☐ Any above the knee amputation or multiple amputations ☐ Suspected pelvic fracture ☐ Any uncontrolled non-compressible hemorrhage S/S of hemorrhagic shock: ☐ HR >100bpm ☐ SysBp <90mmHg ☐ Altered mental status in the absence of head injury Activates walking blood bank: ☐ States that they are going to activate the walking blood bank and collect a unit of blood from their low titer O donor			
b. Blood collection bag inspected and labeled properly ☐ Collection bag inspected for expiration date, sodium citrate solution, rips or tears, infiltrates ☐ Needle inspected: not broken or bent ☐ Donor ID number and date/time clearly labeled ☐ Correct blood type and Rh factor circled ☐ Donor initials on label ☐ Collection start and finish time documented ☐ Collectors name			
c. Student verbalizes venipuncture with and demonstrates aseptic technique ☐ Tourniquet placed appropriately at least 3–4" above collection site ☐ Cleans 2–3 inch around site with Chlora prep for30s, allows to dry for 30s	C		
d. Correct use of collection equipment ☐ Pre-placement of 2 loose knots in line ☐ Hemostats clamped 1–2" below collection needle, released AFTER vascular access is gained			
e. Satisfactory Donor Care & Safety ☐ Donor placed in a seated position ☐ Positive control of needle maintained OR line secured with tape	C		
f. Agitate blood bag q2 minutes (once student appropriately demonstrates one agitation, instructor will prompt "Your bag appears to be full."			
g. Appropriately discontinue collection ☐ Clamp line with hemostats ☐ Knots tied tight ☐ Verbalize direct pressure with gauze on venipuncture site ☐ Collection tubing secured with hemostats			
h. Hangbag *at this point the "dry" collection bag is switched for the simulated blood bag			

(continues)

FIGURE S2 *Cont.*

2. Blood administration	**C**	**P**	**F**
a. Blood bag and administration tubing inspected and labeled appropriately (student must fulfill all criteria for full credit) ☐ correct donor information ☐ inspects foreign debris (cannula tip, etc.) ☐ inspects for bacterial contamination ☐ visualizes and palpates for clots ☐ no kinks or defects in the line ☐ cap on the end of the line has not been removed or contaminated ☐ "Administered by" filled ☐ administration start time noted	C		
b. Prime Y-tubing with blood			
b1. Ensure that filter chamber is full and upper chamber is 2/3 full			
c. Student verbalizes venipuncture with and demonstrates aseptic technique – cleans 2–3 inch around site with Chlora prep for 30s, allows to dry for 30s	C		
d. Blood line hooked directly to catheter	C		
e. Baseline vital signs assessed and taken q5 min for adverse transfusion reaction. Student will take one set of actual vitals on "patient" and plot in 1st box of DD 1380. ☐ Heart Rate ☐ Blood Pressure ☐ Respiratory rate ☐ SpO_2 ☐ Mental status (GCS or AVPU)			
f. Prompt student, "Your patient starts to exhibit stridor, distributed hives, angioedema, and erythema." Student needs to identify adverse reaction and verbalize appropriate actions ☐ Discontinue transfusion ☐ IV diphenhydramine 25mg ☐ Supportive treatment ☐ Administer epinephrine 0.3mg IM			
g. Blood transfusion complete. Evaluator note stop time: _____(MM:SS)			
Total score out of 23 possible points: • C is worth 2 points • All other items worth 1 point •More than 1 critical failure will result in an automatic failure for the evolution			
3. Post-transfusion checklist			
a. All rollers clamped			
b. All lines and IV access discontinued			
c. Donor monitored for 15 minutes for any adverse reactions			
d. Sharps and biohazard disposed of appropriately			
e. Training site sanitized appropriately			

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