

Training of medical students in the use of emergency whole blood collection and transfusion in the framework of a civilian walking blood

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Abstract

Introduction: In this report, we describe a training program in emergency whole blood collection and transfusion for medical students at the University of Bergen. The overall aim of the program is to improve the availability of early balanced blood transfusion for the treatment of patients with life-threatening bleeding in rural health care services.

Study Design and Methods: The voluntary training program provides the knowledge needed to practice emergency whole blood transfusions and understand the system for emergency whole blood collection in the framework of a civilian walking blood bank (WBB). It includes theoretical and practical sessions. In-person teaching and web-based learning resources are provided. An anonymous survey of the students attending the training course in the autumn of 2022 and spring 2023 was performed.

Results: 128 of 178 students participated in the practical training. 88 of 128 (69%) responded to the survey. 82 (93%) performed blood typing, 71 (81%) performed donor interviews, 61 (69%) partially performed whole blood collection (up to blood in bag) and 27 (30%) participated in complete whole blood collection and performed autologous reinfusion. No complications occurred during training. The students reported that the training course increased their understanding of how to ensure access to emergency blood transfusion by the use of a WBB.

Discussion: Structured theoretical and practical training in emergency whole blood collection and emergency transfusion is feasible and of interest to medical students. A multidisciplinary approach to student training in emergency whole blood collection and transfusion should be considered.

KEYWORDS

education, emergency collection, emergency transfusion, transfusion management, walking blood bank, whole blood, whole blood, whole blood bleeding

Abbreviations: CPDA, citrate-phosphate-dextrose adenine; FWB, fresh whole blood; RBC, red blood cell; RhD, rhesus D; WBB, walking blood bank.

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1 | INTRODUCTION

Civilian and military guidelines recommend early balanced transfusion to patients with life-threatening bleeding to improve survival.^{1,2} To provide the best care to patients with hemorrhagic shock in regions with reduced access to medical evacuation, blood preparedness must be considered on all health care levels. The Norwegian Blood Preparedness project is established to develop and pilot a national system for blood preparedness based on the following three principles: (1) Early balanced transfusion should be provided for patients with life-threatening bleeding, (2) Management of an emergency requires a planned and rehearsed day-to-day system for blood preparedness, and (3) A decentralized system for obtaining blood and blood components is needed to ensure local self-sufficiency in an emergency.³

Whole blood offers a balanced ratio of red cells, plasma, and platelets in a logistical advantageous way. It has been, and is, used for the treatment of patients with major hemorrhage both in the military and civilian settings,^{4–11} and results of recent prospective studies of the use of low titer group O whole blood indicate improved survival and reduced blood usage in trauma patients.^{10,11} Challenges are recognized both for isolated health care facilities and sophisticated modern health care systems when it comes to ensuring the availability of emergency transfusions for patients with life-threatening bleeding.^{2,12} We have previously described our experience with whole blood-based blood preparedness programs for level 1 trauma hospitals, for small rural hospitals with limited blood inventories, and in municipal health care services.^{3,13,14}

The term Walking Blood Bank (WBB) describes the collection of whole blood from a prescreened emergency donor pool for emergency use at the site of need.¹⁶ Freshly drawn warm whole blood have been used successfully for trauma patients in military services.^{4,15} However, the use of WBBs is not restricted to patients with bleeding due to trauma, but can be used for all causes of bleeding that require a balanced transfusion. WBBs are used both in military and civilian medical services.^{8,13,14,17–23}

Management of patients in hemorrhagic shock are resource demanding. Specific training and regular rehearsals are necessary to establish and maintain the competence needed. It is important to start training early to ensure best practice. Training programs in emergency whole blood collection in the framework of a WBB have been developed and practiced for military personnel.^{8,24–26} In the Norwegian Blood Preparedness project, multidisciplinary programs are being developed tailored for a civilian municipal health care service.³

In this report we describe a training program developed for medical students at the University of Bergen.

The training program provides theoretical and practical knowledge in emergency whole blood collection and transfusion in the framework of a WBB for the treatment of patients with life-threatening bleeding in rural health care services.

2 | MATERIALS AND METHODS

2.1 | The blood transfusion service in Norway

Norway has a Government-funded decentralized health system. The Regional health authorities administer the hospitals. The blood transfusion service in Norway is located at the hospitals organized as blood services that collect, produce, store, and distribute blood. They also perform all laboratory services needed. In 2021, 150,000 RBC transfusions were given in Norway and a total of 215,000 blood component transfusions were reported. The individual governmental funded hospital-based blood services are regulated by a national directive, the “Blodforskriften”,²⁷ and relevant European regulations. WBBs are subject to the supervision and administration of their local hospital-based blood service, and specific approval as such must be given by the National Health Directorate before implementation.

2.2 | Overview of transfusion training program

Transfusion medicine is included in the curriculum in the 3rd, 4th, and last years of the 6-year medical school program at the University of Bergen. In addition, basic immunology and laboratory medicine are taught in the early years. The training is organized as a step-wise program, starting with basic knowledge and gradually exploring the clinical use of blood transfusion and best practices for treatment in different patient populations. The training in emergency whole blood collection and transfusion has since 2019 been a part of the curriculum for the final year of the medical school. The training course is provided through a collaboration between the University of Bergen and the Department of Immunology and Transfusion Medicine, Haukeland University Hospital, Bergen, Norway.

2.3 | Aim of emergency whole blood collection training program

The training program aims to give the students the theoretical and practical knowledge needed to be able to

practice emergency blood transfusions. Further, we aim to give them insight into what is needed to establish a system for emergency whole blood collection within the framework of a WBB. This includes practical training in the collection and administration of whole blood, knowledge of the pathogenesis and physiology of bleeding, and indications for transfusion in the emergency setting.

2.4 | Content of the training program

The training program consists of a theoretical and a practical session. For both sessions, in-person teaching and web-based learning resources are provided. The participation in the training program is voluntary. The students are advised to prepare for the sessions by going through web-based learning material. The web-based learning material summarizes the basic theoretical knowledge of blood transfusion including blood donation, production of whole blood and blood components, principles of WBB, indications for transfusion for different patient populations, regulatory aspects, and transfusion reactions. It also includes practical procedures describing how to perform whole blood collection, interview of emergency whole blood donors in a WBB, and documentation of whole blood collection and transfusion in a WBB setting. An e-learning course in practical transfusion is provided. The pre-course preparation does not include practical skills such as venipuncture and/or cannulation as this should be known to the students based on previous training. Discussions and questions are encouraged before, during, and after the training sessions. The theoretical and practical training sessions are given within a timeframe of two days, with practical sessions the same day or the day after the theoretical session.

The theoretical part of the training is given as lectures (3.5 hours) for the whole group of students (up to 90 students). The theoretical curriculum describes actions needed to establishing a WBB and the use of emergency whole blood transfusion. This includes regulatory requirements for the establishment of a civilian WBB, selection criteria for emergency whole blood donors, physiology of hemorrhagic shock, indications of emergency transfusion, monitoring of transfusion with regard to effect and safety, and finally, post-transfusion follow-up of patients receiving emergency whole blood transfusion and emergency donors for quality assurance and evaluation of practice. It emphasizes that a risk-benefit analysis is needed for any blood transfusion whether it be elective or in emergencies.

The practical hands-on training (2 hours) is given to smaller groups of students (up to 20). In the practical

training session, the following procedures are performed by the students: ABO-blood and RhD typing by use of rapid tests, interview of the emergency whole blood donor, whole blood collection, and autologous reinfusion of fresh whole blood (FWB) (i.e., the donor receives his or her blood in return after donation). The practical training is voluntary, and the students can choose to perform parts of or the complete procedures. The instructors encourage the students to use the opportunity to learn the procedures but emphasize that it is voluntary and that participants do not influence the assessment of the students. The procedures are demonstrated by the instructors in the session. In the practical training session, we have a high instructor to student ratio (1:4), and the instructors are experienced physicians (anesthesiologists and specialists in transfusion medicine) and blood bank personnel.

2.5 | Procedure for emergency whole blood collection

The procedure used in Norway for emergency whole blood collection and the establishment of a civilian WBB have been described and published previously.³ The whole blood collection is performed according to a detailed step-by-step description. For whole blood collection training, we use a whole blood collection set that contains integral access ports for the connection of infusion sets to enable immediate transfusion (Single blood bag CPDA-1 450 mL, Terumo BCT Europe). The students perform emergency donor interviews and prepare the bag for collection before performing the whole blood collection. Students not wanting to perform a complete whole blood collection/donation are encouraged to perform all steps of the procedure up to the first drop of blood in the collection bag. This includes the venepuncture and blood sample collection. We allow a complete whole blood collection and reinfusion only if the students qualify as a regular donor according to Norwegian Blood Donor selection criteria. If a student is pregnant, under medical examination for a potential illness or undergoing medical treatment, they are excluded from donation. A peripheral venous catheter must be inserted before the whole blood collection if autologous reinfusion of the blood is planned. It is critical that the blood bags are labeled correctly to ensure traceability. As part of the donor interview and preparation for whole blood collection set before the collection, the blood bags are marked with a unique donation identification number that can be traced back to the donor. To be allowed to perform a reinfusion of blood during the training, the whole blood bag must be marked with the unique donation identification

number, name of student, blood type, and time of donation to ensure that the donor receives his or her own blood back. Before reinfusion of blood, the donor is asked to verify that it is his or her blood. In addition, the donation procedure must have been performed in accordance with instructions with no complications or faults during collection, and an adequate volume of blood ensuring the correct ratio of blood to anticoagulant solution must be present.

2.6 | Student survey

To inform instructors on the perception of the relevance of our training program, a survey was developed locally and piloted by students in two consecutive training courses (October 2022 and February 2023). The survey was in Norwegian and distributed electronically through the University learning portal to all students attending the training course. Reminders were given during the practical training session. The survey was anonymous, and the students were informed that the results of the survey would be used for evaluation of the training program and published in a summarized form in a report for a medical journal. The students filled out the survey at the end of or immediately after the practical training course. The questionnaire consisted of eleven questions. Six were yes/no questions focusing on previous experience with blood donation and transfusion, two open-ended questions were asked about whether the students experienced problems during the performance of the procedures during the training and about suggestions for improvement of training course, and two questions were asked for graded responses on satisfaction with and perceived usefulness of the training. Finally, the students were asked to report which procedures they performed during the training session. The questions are reported in

English translation together with the answers in the result section.

3 | RESULTS

A total of 128 of 178 (72%) students participated in the practical training sessions, 58 in October and 70 in February. Seven group sessions were offered. A minimum of four instructors were available during the sessions. 88 of the 128 (69%) students participated in the survey. The gender distribution was 78% (69) female and 18% (16) male. Most students (85/88, 97%) worked or had worked in health care services outside their studies, 30 (34%) were or had been blood donors and 41 (47%) had transfused or ordered blood transfusion to a patient.

During the practical training session, the following procedures were performed: 82 (93%) performed blood typing, 71 (81%) performed donor interview, 77 (88%) prepared the whole blood collection set for collection, 61 (69%) partially performed whole blood collection (followed procedures up to blood in collection bag) and 27 (30%) participated in complete whole blood collection, and autologous reinfusion. No complications occurred during training. When asked about the students' reflections on performing the procedures, they answered that they appreciated the close follow-up from the instructors when going through the procedures, and that help was given when needed. The venipuncture for blood collection and insertion of peripheral venous catheters were described as potentially challenging by some of the students. The students were satisfied with the training course (Figure 1) and reported that the training course increased their understanding of how to ensure access to emergency blood transfusion by use of a WBB (Figure 2).

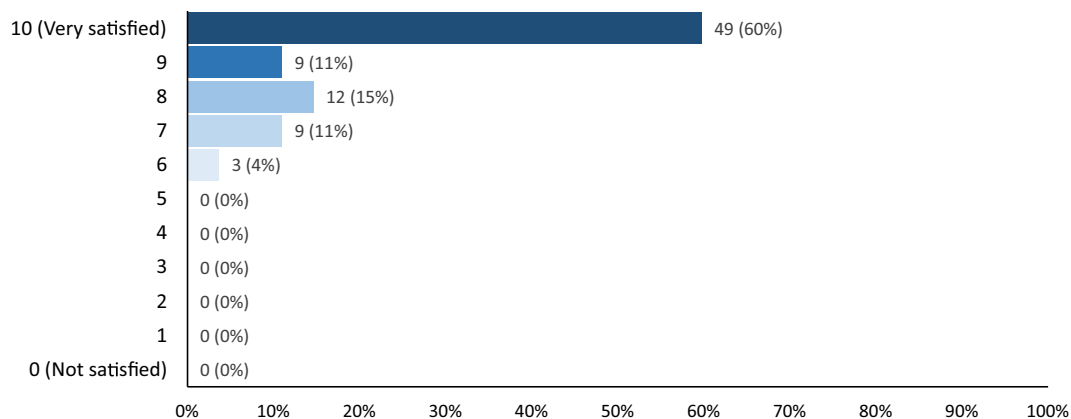


FIGURE 1 How satisfied were the students with the practical training course? ($n = 82$).

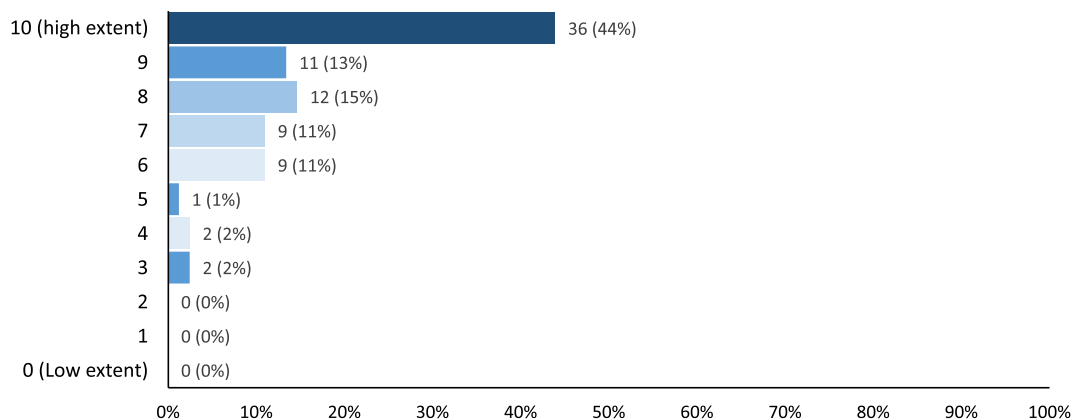


FIGURE 2 To what extent did the training course contribute to an increased understanding of how the students can ensure access to emergency blood transfusion by establishing a walking blood bank ($n = 82$).

4 | DISCUSSION

In this report, we have described a training program for medical students tailored for a civilian WBB setting. Previous publications on training programs in emergency whole blood collection have focused on military settings.^{8,28} These differ from the civilian WBBs mainly when it comes to selection criteria and follow-up of emergency whole blood donors, blood sampling, and documentation procedures.³ The practical procedures used for whole blood collection are, however, mostly similar in military and civilian WBBs. A previous publication from a military program reported on an estimated 3408 autologous transfusions in training with no instances of hemolytic transfusion reactions or other major complications.²⁴ The authors conclude that with appropriate control measures in place, autologous FWB training is low-risk training. This is also our experience from conducting civilian training programs for medical students since 2019.

Management of early balanced transfusion to patients with hemorrhagic shock is challenging and requires a safe and effective system of blood preparedness. However, a decentralized system poses certain challenges when it comes to education and training. It is important to develop education programs that enable early-career physicians and health personnel working in remote areas with the tools needed to provide the best possible care. To do so training must start early. We, therefore, suggest that emergency whole blood collection and transfusion be included curriculum in medical school. A multidisciplinary approach is needed when it comes to training and execution in these situations, and similar, training programs should be considered in the education of other health personnel like nurses, paramedics, and laboratory personnel. In the future, multidisciplinary training

programs in emergency whole blood collection and transfusion would be of importance to give students from different health professions experience, knowledge, and collaboration skills in handling patients with life-threatening bleeding in resource-limited settings.

An emergency is better managed if the procedures involved are planned and rehearsed, and since these are not frequent events, a system for regular rehearsals is essential for the success of the program. The training and education of personnel must be adjusted to local needs. Establishment of a civilian WBB requires systems for training and maintenance of the competence needed in the health personnel. It also requires a systematic approach to recruit and retain an emergency whole blood donor pool. During the training, our students gather experience both on being an emergency blood donor and being the personnel collecting and transfusing whole blood.

The feedback given by our students encourages us to continue the development and optimization of our training course. The timeframe given for the practical training is limited, however, the students are given an insight in what can be achieved by implementation of an organized system for emergency whole blood collections in the framework of a WBB. The students report that the training course contributes to a better understanding of the use of emergency blood transfusions and the system needed to establish a program for emergency whole blood collection. Few of our students may end up working in remote areas, however, several of them may end up working in smaller hospitals with limited resources and restricted blood inventories. Also for these students, the knowledge of the principles for emergency whole blood collections is useful as it may encourage them to establish and create support for a whole blood-based preparedness system within the frames of a local hospital blood bank.¹³

In this report, we have described our training program. As part of this description, we have gathered information on the students' perception of the usefulness of the training by using a locally developed survey. During the development of the survey, we tried to limit the number of questions to a minimum, however, as some of the students did not respond to the survey, they may have found it too time consuming. In the work with further development of our program, we will further investigate literature on standardization of questionnaires to improve usefulness for the evaluation of the training program.²⁹ Another limitation of our survey may be the small sample size. As our program moves forward, we will continue surveying the students and gain more experience and knowledge of how to best assess the students learning and improve our training course.

It is difficult to measure to what extent participation in this training course will lead to the establishment of more WBB in the future. But based on the feedback given by the students during and after the training, we believe that this training course is an experience that the students will remember and that they will be more likely to participate in a WBB in the future than before they took the program.

We conclude that specific training in management of emergency whole blood collection and blood transfusion is feasible and of interest to medical students. We encourage increased focus on multidisciplinary educational efforts to improve the availability of emergency whole blood collection and transfusion as part of blood preparedness programs to enable early balanced blood transfusion for all patients with life-threatening bleeding.


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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest relevant to the manuscript.

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