A SURVEY OF CANADIAN ARMED FORCES NURSING OFFICERS’ KNOWLEDGE OF BLOOD TRANSFUSIONS

by

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A Survey of Canadian Armed Forces Nursing Officers’ Knowledge of Blood Transfusions

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ABSTRACT

BACKGROUND:
Uncontrolled hemorrhage is the leading cause of preventable death on the battlefield. Canadian Armed Forces (CAF) Nursing Officers are heavily relied upon to have the knowledge to safely collect and administer blood products in remote and austere environments with access to few resources, including access to appropriate laboratory storage and testing facilities. The primary objective of this study was to provide a baseline of the current level of knowledge of collecting and transfusing blood products among Nursing Officers within the CAF.

METHODS:
A non-experimental cross-sectional study was conducted using an online internet-based questionnaire (Stat59, MedStatStudio, Edmonton, AB, Canada). Participants were General Duty Nursing Officers, Perioperative Nursing Officers and Critical Care Nursing Officers within the CAF holding a provincial license as a Registered Nurse. Three areas of transfusion medicine knowledge were assessed: pre-transfusion, transfusion process and adverse reactions.

RESULTS:
Seventy-five participants began the survey, and there were 45 completed responses. Median experience as a medical professional was 8.1 years (range 0 to 25 years). Participants came from a variety of previous experiences including emergency department (28 participants; 62%), medical ward (20 participants; 44%), surgical ward (19 participants; 42%), primary care (19 participants; 42%), and intensive care (10 participants; 22%). Twelve participants (27%) had performed transfusions in the preceding 6 months, and 20 (44%) had had previous in-service training on transfusion medicine. The majority of participants indicated a desire for further training in areas such as transfusion reactions (35 participants; 78%), indications for various blood products (33 participants; 73%), transfusion of blood products (29 participants; 64%), and screening of potential donors (24 participants; 53%).

The mean score on the survey knowledge test questions was 31.9 / 45 (71%). (Range: 29% to 91%). There was no significant correlation between the overall score on the knowledge test and the number of years of experience as a Registered Nurse, type of previous experience, or number of transfusions performed in the previous 6 months, or attendance of a previous in-service.

Analysis of the internal structure validity of the survey tool revealed a coefficient alpha of 0.78; indicating adequate reliability for survey purposes.

CONCLUSIONS:
Many CAF Nursing Officers could benefit from additional knowledge regarding blood transfusions in order to safely administer blood products when caring for a hemorrhagic patient in an austere environment. Particular areas of concern include ABO compatibility, massive
transfusions, applicable use of blood tubing, and recognizing severe adverse reactions. Further studies with a larger sample size and more rigorous assessment of validity may be indicated to further clarify these findings.
INTRODUCTION

The leading cause of preventable death on the battlefield is uncontrolled hemorrhage.\textsuperscript{[1,2]} Research has shown that in a hemorrhagic patient, excessive use of crystalloids can cause significant detrimental effects. These effects include dilutional coagulopathy, abdominal compartment syndrome, multiple organ failure and death.\textsuperscript{[3,4]} In response to current research, the importance of early administration of blood and unknown time for patient evacuation from the point of injury in austere environments, the CAF is pushing blood products further forward into the prehospital environment. The North American Treaty Organization (NATO) has established a recommended timeline of 10 minutes to tactical combat casualty care (TCCC), 1 hour to damage control resuscitation (DCR) and 2 hour to damage control surgery (DCS).\textsuperscript{[3]} This is also known as the 10:1:2 rule. As a result, in an emergent situation, those deployed forward require the knowledge and skills to safely administer blood products without continuous reliance on outside resources within one hour of wounding. This may include the collection of whole blood in a pre-hospital setting such as at a casualty collection point (CCP).\textsuperscript{[3,4,5,6]} The CAF Nursing Officers play a very unique role in the collection and administration of blood products overseas. On deployed international operations in austere environments, blood becomes a limited and precious resource. In emergent situations, Nursing Officers are heavily relied upon to have the knowledge base required to collect and administer whole blood and to safely administer blood components to hemorrhagic patients.\textsuperscript{[5,6]}

The CAF does not currently have a Transfusion Medicine Specialist and the education of Health Care Providers within the CAF has relied mainly on the experience gained by its members while working in civilian institutions, the development of ad-hoc lectures and self-directed study. To date, there have been no studies done to evaluate the level of knowledge among CAF Health Care Providers.

As the emphasis of utilizing blood products over crystalloid fluids is progressing, it was imperative to determine the level of knowledge of those most likely (the nurses) to administer it. The primary objective of this study was to provide a baseline of the current level of knowledge of collecting and transfusing blood products among Nursing Officers within the CAF.

METHODS

This study was a non-experimental cross sectional design. The survey was developed using the most current research and regulations with regards to blood products. The questionnaire consisted of 28 multiple choice questions. These questions were divided into 4 sections: Section A: Pre-transfusion (10 questions), Section B: Transfusion (7 questions), Section C: Adverse Reactions (6 questions) and Section D: Demographic Data (5 questions). Some questions allowed participants to select more than one answer resulting in a total of twenty-eight (28) answers for Section A, eleven (11) answers for Section B, and six (6) answers for Section C. The test blueprint was developed through the use of Canadian Blood Services best practice guidelines and resources. This included national standards as published by the Canadian Standards Association and by Health Canada, and Bloody Easy guides as published by the Ontario Regional Blood Coordination Network.\textsuperscript{[7,8,9,10,11]} These references were used to confirm the correct answers to the questions. The questionnaire was sent to a Registered Nurse working in an intensive care unit at a level 1 trauma center for an outside perspective and two senior Registered Nurses within the CAF to ensure questions were understandable and to identify any other key
areas of transfusion medicine that would be considered critical in the performance of an emergency transfusion. All responses to the survey were voluntary and were anonymized to the researchers. The study was conducted as an internet-based online questionnaire. The survey was made available to participants for the months of February and March 2018.

The study population consisted of CAF Nursing Officers that would reasonably be expected to administer blood products on a deployment. This included any Nursing Officer designated as a General Duty Nursing Officer (GDNO), Critical Care Nursing Officer (CCNO) or Perioperative Nursing Officer (PNO) with a provincial license to practice in Canada as a Registered Nurse. Mental Health Nursing Officers were excluded as they would not reasonably be expected to administer blood products on a deployment. GDNOs are expected to rotate between medical and surgical units as well as the emergency department. CCNOs are expected to rotate through the intensive care unit and emergency department. PNOs work primarily in the operating room. There is also the possibility that any of the three designated groups could be placed in a primary care clinic.

A request for volunteer Nursing Officers was sent out by the office of the CAF Chief of Nursing Services and through the Canadian Forces Nursing Officers' Facebook group. Potential volunteers were provided the information for informed consent and a link to the survey. Responses were obtained through use of an online survey tool (Stat59, MedStatStudio, Edmonton, Canada). Reliability of the testing instrument was assessed using Cronbach's coefficient alpha to measure internal consistency reliability. Values of Cronbach alpha greater than 0.7 were considered to be adequate for survey use. Ethical approval was obtained through the Human Research Ethics Committee (HREC) at Defence Research and Development Canada (DRDC). Prior to commencing the questionnaire, participants were required to confirm that they had read and understood the consent form and that they agreed to participate.

Data analysis was performed using Stat59 (MedStatstudio, Edmonton, AB, Canada) with calculations performed by R: A language and environment for statistical computing version 3.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

In total, 45 participants completed the study. Over the last two (2) years, participants have worked on such units as the emergency department (28 participants; 62%), medical ward (20 participants; 44%), surgical ward (19 participants; 42%), primary care (19 participants; 42%), and intensive care (10 participants; 22%). Eighteen (40%) have been practicing as a Registered Nurse, Medical Doctor or Medical Technician for 5 years or less, 15 (33%) have been practicing for 6 to 10 years, 4 (9%) have been practicing for 11 to 15 years, 2 (4%) have been practicing for 16 to 20 years, and 2 (4%) have been practicing for 25 years. In the last 6 months, 30 (67%) respondents have not completed any transfusions, 9 (20%) have completed 1 to 4 transfusions, 1 (2%) has completed 5 to 8 transfusions, and 3 (7%) have completed 9 to 12 transfusions. Two (2) participants did not respond to this question. Twenty (44%) participants responded that they had received some sort of in-service training about blood transfusions while 24 (53%) had not.
received any in-service training. This included but was not limited to pre-deployment training, any online modules, or an in-service at a civilian hospital.

Section A: Pre-transfusion

Of those that completed the survey, 23 (51%) correctly identified that a male patient with an unknown blood type could receive type O positive pRBC while 22 (49%) believed the patient could only receive type O negative pRBCs. Only 1 participant (2%) correctly indicated that a pregnant female patient with an unknown blood type should receive type AB positive plasma while 38 participants (83%) incorrectly believed that the patient should receive type O negative plasma. Twenty-seven participants (60%) correctly answered that a patient with A antigens on their blood cells would have anti-B antibodies. When asked which infectious diseases were routinely tested for by a licensed establishment, the correct responses were answered as follows: 35 (78%) selected Hepatitis B, 37 (82%) selected Hepatitis C, 36 (80%) selected Human Immunodeficiency Virus (HIV), 23 (51%) selected Syphilis, and 21 (47%) selected Human T-Lymphoma Virus (HTLV). Of those that completed the questionnaire, 33 participants (73%) identified the appropriate needle gauge required for administration of pRBCs (16G-18G for rapid transfusion and 20-22G for routine transfusion) and 39 (87%) knew that they could transfuse through an intraosseous (IO) device. Forty-two (42) participants (93%) understood what an order for a type and screen meant.

Section B: Transfusion

When asked which products required blood tubing, 37 participants (82%) correctly identified plasma and platelets as requiring blood tubing and 42 (93%) correctly identified pRBCs. Other respondents incorrectly believed that albumin, fibrinogen concentrate and prothrombin complex concentrate (Octaplex) also required blood tubing. The majority of respondents (85%) correctly responded that it is not safe to temporarily store blood in a medication fridge. Thirty-four participants (76%) correctly identified that in the event of a delay to the transfusion, pRBCs should be returned to proper storage. Thirty-one (31) participants (69%) correctly identified the frequency at which vital signs should be taken when administering blood products. Only 6 respondents (13%) correctly identified a massive transfusion to be defined as a patient receiving more than 10 units of pRBCs and 24 (53%) correctly identified that blood tubing should be changed every 2 to 4 units or every 4 hours.

Section C: Transfusion Reactions

Twenty (20) respondents (44%) correctly recognized fever as being associated with acute hemolytic, febrile non-hemolytic, bacterial contamination, and transfusion-related acute lung injury (TRALI) reactions while 16 (36%) incorrectly identified fever as not being associated with TRALI, 3 (7%) incorrectly believed a fever was not associated with a febrile non-hemolytic reaction and 1 (2%) believed a fever was not associated with an acute hemolytic reaction. Thirty-six (36) participants (80%) correctly associated lower back pain with an acute hemolytic transfusion reaction. Thirty-two (32) participants (71%) correctly associated hypertension with transfusion associated circulatory overload (TACO) and hypotension with TRALI. Forty-three (43) participants (96%) correctly identified that in the event of a transfusion reaction, the initial
response is to stop the transfusion. In patients with a history of mild febrile non-hemolytic transfusion reactions, 26 participants (58%) correctly identified an antipyretic as an appropriate pre-medication.

The survey response score consisted of the number of questions answered correctly of the 45 questions in total. The mean score on the survey test questions was 31.9. (Range: 13 to 41). Cronbach’s alpha was 0.78.

There was no correlation between the overall score and the number of years of experience as a Registered Nurse (Figure 1). There was no significant difference between those that indicated they had received in-service training compared to those that had received no additional training (Figure 2). There were only two participants who had spent time in an operating room and only ten had spent time in an intensive care unit (Figure 3). Finally, there was no significant difference between those who had performed one or more transfusions in the past 6 months compared to those who had not performed any transfusions in the past 6 months (Figure 4).

DISCUSSION

CAF Nursing Officers are heavily relied upon to have the knowledge and skills required to safely administer blood products in remote and austere environments during emergency situations with a hemorrhagic patient or a massive casualty situation. The administration of blood products within one hour of wounding for a hemorrhaging patient has proven to decrease the chance of mortality.3,16,17

The results of this study show that there is a significant gap in knowledge among Nursing Officers regarding ABO compatibility with various blood products, appropriate use of equipment, and what defines a massive transfusion. There are multiple studies that have been conducted in other countries to assess a nurses’ knowledge of blood transfusions. Only one study concluded that nurses had adequate knowledge.19 The majority of other studies conducted to assess nurses’ knowledge of transfusion medicine have classified a high percentage of their sample population of nurses (>50%) as having inadequate or poor knowledge and practice concerning the safe administration of products. This included pre-transfusion compatibilities checks, and recognizing adverse reactions.20,21,22,23 When deployed in austere conditions, laboratory facilities to conduct a crossmatch prior to administering a blood product are not available. This greatly increases the risk of an acute hemolytic reaction. The Public Health Agency of Canada Transfusion Transmitted Injuries Surveillance System reported 109 instances of acute hemolytic transfusion reactions (AHTR), 211 delayed hemolytic reactions and 51 incompatible transfusions between 2006-2012.24 However, these reports are from hospitals with adequate laboratory testing facilities. The incidence of administering an incompatible blood product would likely be greatly increased in chaotic environments lacking laboratory cross matching capability.

Although there is a slight increase in the number of correct responses of those that had received in-service training (Figure 2) and a slight increase in the number correct responses among those who had performed a transfusion in the last 6 months (Figure 3), these are not statistically significant differences.
This lack of knowledge in certain areas, particularly understanding ABO compatibilities, is concerning because it is the nurses that are the final check before administering a blood product to a patient. If the nurses do not fully understand the indications, appropriate ABO compatibilities, equipment for administration, and recognizing an adverse reaction, then there is a much greater potential for causing harm to the patient. This is especially true in an emergency situation in a far forward environment with a lack of resources while caring for an uncontrolled hemorrhagic patient.

Ensuring the validity of the survey questionnaire was attended to throughout the survey process. Firstly, to ensure content validity the survey blueprint was constructed by reviewing standard reference materials. In addition, this test was reviewed by content experts in the field to ensure that content was appropriate for the level of knowledge expected to safely carry out a transfusion. Internal structure validity was assessed using Cronbach’s alpha as a measure of internal consistency. The value of Cronbach’s alpha of 0.78 indicated adequate reliability for survey use as detailed in “How to Measure Survey Reliability and Validity.” The relationship of test overall score to other variables was also performed in order to further assess validity. However, this study failed to find a significant relationship between overall score and years of experience or between overall score and previous training sessions. This finding would require further study, as it may be an indicator of either inadequate validity of the survey instrument or an indicator that neither experience nor existing training programs are adequate to maintain competency in transfusion.

One limitation to this study was the small sample size of participants. There were only 45 participants who completed the entire questionnaire. Only two participants indicated they had spent time in an operating room while only ten indicated they had spent time in an intensive care unit. A second limitation to this study was the dissemination of the questionnaire. Due to the time constraint and participants being recruited from across the country, electronic communication was the sole recruiting tool. This also meant that the dissemination of the questionnaire relied on participants belonging to a distribution list or to the Canadian Forces Nursing Officers’ Facebook group. Finally, although survey validity was assured through the process of content validity (test blueprinting) and internal consistency, the assessment of relationship to other variables puts the survey’s validity into question. Further assessment of response process and consequences of testing could be considered to further clarify the validity of the instrument.

This survey was designed to evaluate a CAF Nursing Officer's general knowledge about blood collection and transfusion. Some answers may have been biased if nurses were reliant solely on their knowledge of one civilian institution's protocols rather than protocols that would apply to all blood transfusions.

**CONCLUSIONS**

Many CAF Nursing Officers could benefit from additional knowledge regarding blood transfusions in order to safely administer blood products when caring for a hemorrhagic patient in an austere environment. While the questionnaire was created to reflect Canadian standards, guidelines and regulations, there are consistent findings with other studies in various countries.
Some areas in which nurses seemed to lack knowledge include ABO compatibilities, the influence of antigens and antibodies on compatibilities, selecting appropriate tubing for products that are considered to be blood products but do not require filtered blood tubing, what constitutes a massive transfusion, and recognizing a transfusion reaction. While no significant difference existed between those who had received additional training, there are other studies that indicate a correlation between education and improved knowledge. Methods to increase the level of knowledge among CAF Nursing Officers should be explored. This would potentially increase patient safety when receiving an emergency transfusion in remote and austere environments, and potentially conserve resources in a resource deficient setting. Further studies with a larger sample size and more rigorous assessment of validity may be indicated to further clarify these findings.

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Figure 1. Overall score versus number of years as a Registered Nurse
Figure 2. Receipt of in-service training prior to completion of survey.
Figure 3. The type of unit which the nurse has worked.
Figure 4. The number of transfusions performed by participants.