



Educating the next frontier of transfusionists: a transfusion camp pilot program for nurse practitioners

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BACKGROUND: Blood transfusion is common and potentially lifesaving but is associated with risk and overuse. Nurse practitioners (NPs) in multidisciplinary care teams are increasingly expanding their scope of practice to transfusion medicine (TM). Resources aimed at NPs are lacking, and little is known about NP TM knowledge. Thus, we developed a pilot TM curriculum for NP credentialing and assessed its impact.

METHODS: NP leads and TM directors adapted the successful Canadian Transfusion Camp for medical postgraduate trainees into a 3-day curriculum for NPs. Two modalities were used to assess the pilot: 1) a participant demographics survey and needs assessment; and 2) the validated BEST-TEST knowledge assessment exam administered before and after the course.

RESULTS: Of the 23 volunteer participants, the majority reported prescribing blood products within the last year, primarily red blood cells. Minimal opportunities to undertake continuing medical education in TM were identified. NPs often used preprinted order forms, consultation with physicians sharing care, or local fact sheets to guide transfusion; rather than TM physician consultation or guidelines.

Exam scores significantly improved after the course (before, 35.2% vs. after, 50.3%; $p = 0.005$), suggesting average initial knowledge being below medical postgraduate trainee-level improving to postgraduate trainee level. Questions on appropriate transfusion triggers and correct recipient identification were most correctly answered; and responses to transfusion reaction questions required improvement.

CONCLUSIONS: Our needs assessment suggests that TM resources for NPs are relevant but lacking. Our initiative supports the generalizability, scalability, and effectiveness of the Transfusion Camp program. Further implementation, refinement, and future impact assessments are required.

Blood transfusion is one of the most common procedures administered in hospitals, with over 21 million units transfused in the United States alone annually.^{1,2} Though transfusion is a lifesaving intervention in medical practice, it is associated with risk, and its overuse has been identified by multiple professional societies.³ Multiple reports suggest that transfusion medicine knowledge is poor among physicians and physician trainees, and little education is delivered during the formative stages of these practitioners.^{4,5} Thus, inappropriate transfusions are common in a variety of settings, and transfusion medicine (TM) physicians have placed clinician education as a priority in their efforts.⁵

Nursing as a profession has a rich history of administering and monitoring blood transfusions.⁶ Over the past few decades, the creation of roles such as specialized transfusion nurses including transfusion liaison nurses, transfusion safety

ABBREVIATIONS: APPs = advanced practice providers; NPs = nurse practitioners; TBL = team-based learning; TM = transfusion medicine.

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officers, and patient blood management nurses have been adopted internationally as best standard of care. These roles have been well developed and are complementary to modern multidisciplinary care team models. As health care expenditures, accountability for resource utilization, service needs in remote and specialized areas, and staff demand pressures increase, the prescription of transfusion has expanded to care providers for which it was traditionally a noncore competency.⁷ Nurse practitioners (NPs) in multidisciplinary care teams prescribing transfusions are increasingly common in clinical areas including hematology-oncology, medical oncology, and the intensive care unit.^{8,9} Over 5000 advanced practice providers (APPs) in the United States, mostly composed of NPs, practice in oncology, and many states allow NPs to practice with full autonomy.¹⁰ However, there is a paucity of educational resources aimed at NPs, and little is known about the knowledge and competency of NPs to practice transfusion after their initial training educational curricula and practicums.⁸

In the province of British Columbia, Canada, NPs have been variably credentialed in different jurisdictions to prescribe blood transfusions. In an effort to standardize the credentialing process and training for NPs to prescribe blood and blood products, we have adapted the successful Transfusion Camp curriculum for medical postgraduate trainees as a transfusion curriculum for NPs in British Columbia.¹¹ In this report, we describe the development of this adaptation and the initial implementation of this pilot program.

METHODS

Educational program development

Transfusion Camp was originally developed with a target audience of nonhematology specialty-based medical postgraduate trainees. The original program occurs over 5 days, with two to three didactic lectures followed by small-group modified team-based learning (TBL) seminars led by a local physician expert.¹¹ Though physician leads typically are TM physicians, the detailed answers and rationales provided in the TBL seminar cases allow for non-TM experts to be seminar leads.

Before the development of the Transfusion Camp program for NPs, credentialing occurred with the completion of an online transfusion course called “Bloody Easy Lite” (Fig. 1).¹² In September 2018, transfusion medical directors at adult and pediatric hospitals (AWS and DM) and a nurse practitioner who is a department head and director of NPs (JB) adapted the Transfusion Camp for NPs. As the educational program was also used for the credentialing and privileging of NPs to prescribe blood and blood products, different educational goals were needed for family care NPs compared to acute care NPs, and based on a pilot needs assessment administered to a small focus group of NPs (DM and KC), the program was shortened. Instead of a 5-day course, a 3-day course was developed and piloted with all NPs required to attend the first 2 days and acute care NPs

The figure displays three screenshots from the 'Bloody Easy Lite' online course. The leftmost screenshot shows the 'Module 1 - Indications for Blood Transfusion' interface, featuring an index on the left, a main content area with text and diagrams of hemoglobin levels, and a 'Glossary' button at the bottom. The middle screenshot shows 'Module 2 - Transfusion Reactions', with an index on the left, a main content area discussing TACO management and prevention, and a 'Glossary' button at the bottom. The rightmost screenshot shows a test question titled 'Test 1 - Indications for Blood Transfusion' with four multiple-choice options and a 'Save and Return' button.

Fig. 1. Example screenshots of the online course Bloody Easy Lite. The left side of the figure demonstrates screenshots of the different modules covering different aspects of transfusion including indications and transfusion reactions. Each course is also associated with a multiple-choice test afterwards to test the participant’s knowledge, with an example shown on the right.

required to also attend the third day of the program. The learning objectives and the topics covered for each day in the adapted pilot version for NPs are listed in Table 1. The modifications to the original Transfusion Camp curriculum¹¹ (designed for MDs) included removing lectures on sickle cell disease management, prescription of plasma-derived fractionated blood products, specific management of inherited bleeding disorders, and perioperative blood management. After advertising the curriculum through provincial NP leads, NPs voluntarily enrolled and participated in the program from different health authorities in British Columbia from February to April 2019, where all sessions occurred in person with prerecorded didactic lectures from Transfusion Camp and TBL seminars prepared by Transfusion Camp with minor adaptations (to remove content not covered in the lectures) and moderated by two TM directors (AWS and DM). Participants were paid educational leave and were responsible for their travel arrangements. This course was deemed a requirement for credentialing to prescribe blood and blood products by different health authorities in British Columbia. The course was otherwise offered for free, cosponsored by the British Columbia Provincial Blood Coordinating Office and the Vancouver Coastal Health Regional Department of Nurse Practitioners.

Survey/needs assessment and outcome measures

The pilot curriculum was assessed using 1) a participant demographics survey and needs assessment; and 2) a TM knowledge assessment administered both before and after the course. The demographics survey and needs assessment

was administered at the beginning of the first day of the program. The 20-multiple-choice-question survey captured participants’ primary practice setting, demographics, general experience and experience specific to transfusion, use of other educational materials and decision support tools, and whether prescribing transfusions generally occurred with physician consultation. The BEST-TEST™ knowledge assessment used was a validated 20-question multiple-choice exam developed by the Biomedical Excellence for Safer Transfusion collaborative.^{13,14} The exam was administered before and after the course, where all NPs completed the exam before the course, and acute care NPs taking all 3 days of the course completed the exam after the course. The exam included some concepts not covered in the first 2 days alone (such as massive transfusion). Research ethics board approval was waived, as this was deemed a quality improvement project for evaluating an educational program.

Our primary outcome was the difference between the pre- and postcourse exam results for the pilot program. Comparisons between individual exam question results were performed using Fisher’s exact test or the chi-squared test where appropriate; and for overall exam results were performed by the Student t test or the Mann–Whitney U test if the data were parametric or nonparametric, respectively. Statistical testing taking data dependency into account was not used given the small number of test subjects and because not all NPs performed both pre- and postcourse exams, where this would make our statistical testing more conservative, as it would err toward the null hypothesis. A two-tailed p value of less than 0.05 was considered statistically significant.

TABLE 1. Adapted Transfusion Camp learning objectives and educational program

Learning objectives	
Indications for blood products	
1. Appropriately prescribe components (RBCs, plasma, platelets, and cryoprecipitate)	
2. Perform a preoperative bleeding history	
3. Interpret coagulation testing results	
4. Have a reasonable approach to the correction of coagulation prior to procedures	
Blood bank testing	
5. Summarize basics about blood bank tests and pretransfusion compatibility testing	
6. Explain the implications of a positive antibody screen	
7. Know when to screen patients for platelet alloimmunization	
Risks of transfusion	
8. Obtain informed consent for transfusion	
9. Prevent, diagnose, manage, and report acute and delayed transfusion reactions	
10. State the current risks of transfusion-transmitted infections	
11. Describe challenges to transfusion safety (getting the right blood to the right patient)	
Special transfusion situations	
12. Develop an approach to patients with congenital or acquired bleeding disorders (including reversal of common anticoagulants)	
13. Manage a patient who is massively hemorrhaging, including surgical, trauma, and obstetric patients, with discussion of hemostatic medications (antifibrinolytics)	
Educational program	
Day	Topics covered
1	RBC transfusion, blood bank testing, platelet transfusion, plasma transfusion, cryoprecipitate/fibrinogen concentrate/prothrombin complex concentrate transfusion
2	Anemia/transfusion in pregnancy, informed consent, transfusion-transmitted infection, noninfections/delayed transfusion reactions
3	Pediatric transfusion, bleeding assessment, massive hemorrhage protocol, oral anticoagulants, and antiplatelets

TABLE 2. Characteristics of nurse practitioner Transfusion Camp trainees and blood products prescribed (n = 23)

Years of experience, n (%)	Was the Bloody Lite course helpful?, n (%)	Prescribed blood products	Every day, n (%)	At least once a week, n (%)	Once a month, n (%)	Less than once every few months, n (%)	Very rarely, n (%)	Never, n (%)
<2 years	6 (26)	0 (0)	0 (0)	6 (26)	8 (35)	2 (9)	0 (0)	6 (26)
2-5 years	6 (26)	6 (26)	0 (0)	0 (0)	2 (9)	7 (30)	0 (0)	9 (30)
6-10 years	2 (9)	5 (22)	0 (0)	0 (0)	2 (9)	2 (9)	3 (13)	12 (52)
Over 10 years	9 (39)	5 (22)	0 (0)	0 (0)	1 (4)	1 (4)	4 (17)	13 (57)
Primary patient demographic								
Family (adult and pediatric)	5 (21)	1 (4)	0 (0)	0 (0)	0 (0)	2 (9)	2 (9)	15 (65)
Adult	16 (70)	6 (26)	0 (0)	1 (4)	0 (0)	1 (4)	2 (9)	10 (43)
Primary practice setting								
Outpatient, primary care clinic	4 (17)	1 (4)	0 (0)	1 (4)	0 (0)	1 (4)	1 (4)	8 (35)
Specialty outpatient clinic, multidisciplinary	5 (22)	2 (9)	0 (0)	Usually	Occasionally	Rarely	Never	Unaware of Resource
Specialty multidisciplinary care team (out/inpatient)	3 (13)	2 (9)	11 (48)	3 (13)	4 (17)	0 (0)	0 (0)	1 (4)
Specialty multidisciplinary care team (inpatient)	11 (48)	2 (9)	10 (44)	0 (0)	1 (4)	0 (0)	3 (13)	2 (9)
Prescribed blood products in past year								
Yes	14 (61)	12 (52)	4 (17)	5 (22)	2 (9)	1 (4)	1 (4)	3 (13)
No	7 (30)	10 (44)	3 (13)	1 (4)	3 (13)	1 (4)	2 (9)	4 (17)
Unanswered	2 (9)	1 (4)	1 (4)	2 (9)	6 (26)	0 (0)	2 (9)	2 (9)
Additional education to experiential learning								
Yes, Blood Lite	14 (61)	11 (48)	No knowledge	Beginner	Intermediate	Advanced	Expert	
Yes, another equivalent	2 (9)		1 (4)	19 (83)	2 (9)	1 (4)	0 (0)	
No	17 (30)							

TABLE 3. Comparison of performance on BEST-TEST before and after course

Question topic	Pretest (n = 23)	Posttest (n = 16)	Change in score	p value
RBC transfusion (prophylactic)	61%	100%	39%	0.01
RBC transfusion (blood loss)	70%	88%	18%	0.36
Platelet transfusion (preprocedure)	74%	88%	14%	0.52
Plasma preprocedure	44%	88%	44%	0.008
Reaction reporting	48%	75%	27%	0.17
AHTR etiologies	44%	75%	31%	0.10
Irradiation	61%	69%	8%	0.87
Platelet transfusion (prophylactic)	30%	69%	39%	0.03
Warfarin reversal	44%	69%	25%	0.19
Septic transfusion reaction	17%	56%	39%	0.02
TACO prevention	30%	38%	8%	0.90
Platelet transfusion (postoperative)	61%	38%	-23%	0.27
AHTR clinical presentation	52%	38%	-14%	0.56
TRALI management	0%	31%	31%	0.01
TRALI reporting	26%	31%	5%	0.73
TRALI prevention	0%	31%	31%	0.008
RBC transfusion (symptomatic)	26%	25%	-1%	1.00
Allergic reaction	0%	19%	10%	0.06
Viral transmission risk	26%	19%	-7%	0.71
Massive transfusion	9%	6%	-3%	1.00
Overall scores	35%	50%	15%	0.001

AHTR = acute hemolytic transfusion reaction; TACO = transfusion-associated circulatory overload; TRALI = transfusion-related acute lung injury.

RESULTS

Participant demographics and needs assessment results

The pilot program had 23 participants completing the survey (Table 2), with approximately one-half (48%) being in practice over 5 years, over one-half (61%) mostly practicing in an inpatient setting, and approximately one-half of participants (48%) practicing in a health authority that did not credential NPs for transfusion practice. The majority of participants had prescribed blood products in the past year (61%), always or usually consulted with a physician before prescribing (78%), and had taken the Bloody Easy Lite course (61%). However, the value of the Bloody Easy Lite course was variable among respondents, and only about one-half of NPs knew how to contact a local TM physician (52%); the majority of respondents did not have any opportunities to undertake continuing medical education in transfusion (62%) and rated themselves as having a “beginner” level of TM knowledge (83%). Self-reported transfusion experience was mostly with blood components, notably red blood cell transfusion. NPs often used preprinted order forms, consultation with physicians sharing care, or local blood product information/fact sheets to help guide decision making for transfusion, as opposed to guidelines or consultation with local TM experts.

Knowledge assessment scores

The mean percentage score on the BEST-TEST before the course was 35.2% (standard deviation, 13.9%; n = 23) and after

the course was 50.3% (standard deviation, 12.3%; n = 16). The difference in mean percentage scores was 15.1%, consistent with improvements seen in medical trainee cohorts.¹¹ When assessing specific questions by topic (Table 3), questions regarding appropriate transfusion triggers as well as correct samples and recipient identification had the highest proportion of correct answers. Questions regarding diagnosis and management of transfusion reactions highlight an area requiring improvement. Fewer respondents answered the question regarding postoperative platelet transfusion correctly after the course, as more respondents chose restrictive cutoffs suitable for prophylactic transfusion after the course compared to cutoffs suitable for bleeding patients. Fewer respondents also answered the question regarding the most common first clinical manifestation of a hemolytic transfusion reaction correctly after the course, as more respondents chose hemoglobinuria as an answer after the course compared to fever.

DISCUSSION

The scope of NPs in multidisciplinary and independent practice has been expanding, where many jurisdictions have included prescribing blood and blood products in the NP scope of practice. We endeavored in our jurisdiction to develop an NP-specific curriculum for transfusion adapted from a successful physician-level program.¹¹ Our needs assessment suggests a lack of resources for continuing medical education regarding transfusion competency, and self-perceived competency was low. NPs consult with other physicians and use preprinted order forms to guide

transfusion practice but had little contact with TM experts or guidelines. Our NP-specific curriculum demonstrated gains in TM knowledge consistent with medical postgraduate trainees, where education regarding transfusion reactions could be improved.

Educational materials toward nurses in general are increasingly recognized as a need to improve transfusion safety and practice.¹⁵ However, curricula to educate the new generation of APP transfusion prescribers are lacking. The National Health Services Blood and Transplant agency in the United Kingdom does provide a course for nonmedical authorization of blood components, but to our knowledge there is no comprehensive curriculum to educate NPs on transfusion practice in North America.¹⁶ APPs, mostly composed of NPs, reported in a needs assessment that less than 5% of their curriculum was hematology focused, and the vast majority did not feel prepared for hematology-related practice after their curriculum.⁸ TM was named as a specific area that required more formal training. The needs assessment performed before our NP-specific curriculum is concordant with these findings, as the majority of NPs rated themselves as having a “beginner” level of transfusion knowledge and had undertaken little to no continuing medical education in transfusion. The previous inclusion of *Bloody Easy Lite* as education to prescribe transfusions suggests even nationally recognized online resources alone are not sufficient for competency to prescribe alone without background knowledge or expert mentorship. Of note, the results of our pilot program are not a reflection of the effectiveness of *Bloody Easy Lite*, as it was not formally evaluated, not all participants took the course, and it is unclear when participants had taken the course in relation to performing the BEST-TEST. Ensuring that physicians who act as consultants or mentors to NPs have appropriate transfusion practices and making preprinted orders or computerized order entry optimized for best practice are identified as potentially high-yield approaches to improving NP transfusion knowledge based on our needs assessment.

Evidence from the development of nonphysician prescribing demonstrates that NPs prescribe appropriately in a wide range of clinical settings and that both patients and medical staff have positive views on these initiatives.^{17,18} Successful examples of NPs practicing in high-acuity and hematology/oncology-based clinical areas have been reported, and the number of NPs practicing in these areas is growing.⁸⁻¹⁰ Minimal knowledge exists of the competency of NPs to exercise the scope to prescribe transfusions specifically. Based on the use of a validated TM knowledge assessment tool, in our pilot cohort, TM knowledge was likely below the level of a medical postgraduate trainee based on prior assessments using the BEST-TEST.^{4,11,13} After the curriculum, NPs in the pilot program had TM knowledge assessment scores similar to postgraduate year 1-3-level medical trainees.^{4,11,13,14} Gains from the Transfusion Camp in our pilot program are consistent with gains seen in medical postgraduate trainees

attending Transfusion Camp.¹¹ This is despite NPs being unable to access materials for review during the course, the fact many NPs had little exposure to prescribing transfusions, and that not all NPs attended all days of the Camp.

The results on the postcourse exam reflected the anecdotal experience of the seminar moderators in the TBL sessions, where transfusion triggers and consent were concepts better understood than diagnosis and management of transfusion reactions. Thus, the postcourse exam suggests areas where continued medical education would be the most effective. Challenges for both NPs and physicians exist around both strategies to socialize modern transfusion practice to prescribers as well as maintain continued competency. The Transfusion Camp program is appealing given regularly updated didactic lectures and cases for TBL sessions that are already developed, requiring less TM expertise and fewer resources to implement compared to traditional expert-driven curricula that would be implemented in individual jurisdictions. For future iterations of the adapted Transfusion Camp for NPs, experienced NPs that have successfully completed the program may be potential TBL seminar leads to ensure the feasibility, sustainability, and scalability of this program. Identified needs also include mechanisms for determining continued competency for those who have completed Transfusion Camp, to be explored in the future. Given that NPs who participated in our pilot program transfuse less frequently compared to physicians, this further emphasizes the need for accessibility to TM experts and appropriate transfusion mentors as a resource.

Our pilot program has limitations. Though we performed a needs assessment before the course, its results minimally affected the development of the pilot program, which was led by TM directors and an NP leader. A postcourse survey was not administered to gather feedback for the pilot, though subjective reports have been positive. The effectiveness of the adapted Transfusion Camp cannot be confirmed with the small number of participants or the generalized competency of APPs and NPs to prescribe transfusions in other jurisdictions. Though the BEST-TEST has been validated with Rasch analysis, it has not been validated with care providers other than physicians. The BEST-TEST also did not reflect all the material encompassed in the Transfusion Camp and suggested worse performance in some areas after the course, likely due to the small number of learners. Performance on a multiple-choice knowledge assessment tool does not reflect performance in real-world clinical scenarios. This is significant, as the adapted Transfusion Camp in our jurisdiction guides credentialing for NP prescribing of blood and blood products. However, given that NPs were credentialed to prescribe transfusions with lesser education, TM experts in our jurisdiction felt a “gatekeeper” approach would be less effective compared to engaging NPs through knowledge translation to improve competency and establish linkages with TM physicians. Anecdotally, NPs have reported returning to clinical areas to contact TM physicians for consultation and having

constructive discussions with clinical colleagues around appropriate transfusion practice.

In conclusion, APPs including NPs are incorporating prescribing blood and blood products into their scope of practice with a paucity of resources to guide appropriate and safe transfusion. The NP community of practice, similar to physician practitioners, have suboptimal contact with TM expertise. Our jurisdiction adapted the successful TM educational curriculum Transfusion Camp, for the purpose of educating NPs. Use of the validated BEST-TEST knowledge assessment tool suggests improved transfusion knowledge consistent with medical trainees. Future directions include expanding Transfusion Camp to a larger cohort, using needs and knowledge assessment tools to further personalize an adapted curriculum, implementing strategies to maintain competency in an individualized fashion, and ensuring feasibility with limited transfusion expertise observed in many jurisdictions. It is our hope that a better educational stream for nonphysician APPs has the potential to further optimize patient care and produce a new generation of future transfusion leaders.

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CONFLICTS OF INTEREST

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