



Brief Report

Fundamentals of blood banking in anesthesiology: A problem-based learning simulation session as an addition to a novel curriculum of transfusion medicine education for anesthesiology residents

Meaghan R. Kenfield, MD^a, Alex P. Tannenbaum, MD^a, Aaron S. Hess, MD, PhD^{b,c}, William N. Rose, MD^{c,*}

^a University of Wisconsin School of Medicine and Public Health, Madison, WI, USA

^b Department of Anesthesiology, University of Wisconsin Hospital, Madison, WI, USA

^c Department of Pathology and Laboratory Medicine, University of Wisconsin Hospital, Madison, WI, USA

ABSTRACT

We have previously published a novel transfusion medicine curriculum for first-year anesthesiology residents, making available open access learning materials. We now present a curriculum iteration, by incorporating resident feedback and developing an additional “capstone” session for use at the end of the rotation that integrates several learning points into a practical problem-based simulation. This iteration of the curriculum was piloted with the 2019–2020 PGY-1 anesthesiology residents of the University of Wisconsin Hospitals and Clinics. Pre-course and post-course surveys, which assessed trainee understanding of course topics, were used to subjectively evaluate the usefulness of the curriculum. Results of the surveys demonstrated post-test mean scores were significantly increased when compared with the equivalent pre-course questions. This suggests the piloted curriculum iteration serves as a useful tool for resident learning. As an adjunct to our previous existing materials, in the spirit of open-access education, we share this additional curriculum material, consisting of four patient cases with 16 questions that can be used immediately for teaching purposes.

Keywords: Transfusion medicine, Blood banking, Anesthesiology, Education, Curriculum, Materials, Open access

Training anesthesiology residents in transfusion medicine is important for several reasons. In most large hospital settings, anesthesiologists order more than 50% of blood products for transfusion.^{1,2} Transfusion medicine is part of real-life anesthesiology practice and an element of the board certification exam.³ This educational need provides an ideal opportunity for transfusion medicine specialists to “speak for themselves” by training future anesthesiologists in transfusion medicine, rather than delegating this task to anesthesiologists or other non-specialists.⁴

Informed by our previous work in the field, we found that previously published curriculum articles adequately provided conceptual frameworks, such as learning objectives and broad descriptions of activities. However, we were unable to find a curriculum that also included concrete teaching resources.⁵ We sought to develop a curriculum that included novel materials specifically customized for anesthesiology trainees, that was brief enough to fit into a busy trainee education schedule, and that could be accessed free of charge. To these ends, we previously published an article with our “lecture-free” curriculum and complete learning materials.⁶

The curriculum described in this Brief Report was initially developed over a 3-year period, in which subsequent iterations of the course materials were revised in response to resident feedback. To improve upon

the three versions described in our previous article, this article's co-author, A.S.H., created a final “capstone” session. This session focused less on basic recall and more on the advanced tasks of integrating, synthesizing, and applying knowledge to realistic clinical simulation cases.

The objective of this article is to present these recent improvements to our previously published transfusion medicine curriculum for anesthesiology trainees. This includes sharing our materials and experience with a capstone session designed to give the trainees a simulated transfusion experience as a way to practice what they have learned. Our hope is for these changes to be integrated into our published curriculum, and be freely utilized by any interested parties.

Curriculum design

During the 2019–2020 academic year, the entire first-year anesthesiology resident class (post-graduate year-1 [PGY-1]) was enrolled in a one-month intensive course that included fundamentals of blood banking and transfusion medicine. The main learning objectives of the course were to learn and apply the essentials of:

- blood products (composition, preparation, indications, donation)

* Corresponding author. Department of Pathology and Laboratory Medicine, University of Wisconsin Hospital, 600 Highland Ave, Madison, WI 53792, USA.

E-mail address: wrose@uwhealth.org (W.N. Rose).

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- pretransfusion compatibility testing
- transfusion reactions.

The course facilitators included a transfusion medicine specialist (a pathologist) and an anesthesiologist. The basic course content has been described previously.⁶ Didactic materials were presented by the facilitators, as well as guest instructors from the transfusion medicine service. At the end of the course, the facilitators supervised a student-led “capstone” session designed to apply course material to realistic clinical scenarios. We include this new simulation session learning material as [Supplemental Material 1](#), with accompanying facilitator's guide as [Supplemental Material 2](#), to be used as an adjunct to the materials that we previously published.⁶ The supplementary cases were designed specifically to reflect the format and style of the American Board of Anesthesiology oral board examination (“ABA APPLIED”). Initial collaborative input was received from co-authors, and the cases have been adjusted over the last four years to reflect feedback from students.

Survey methods

Having made these curriculum enhancements, we distributed anonymous surveys to 13 PGY-1 residents before and after the completed rotation. Surveys consisted of questions asking the student to rate their familiarity with seven core competencies in transfusion for anesthesiology residents. Responses were on a five-point Likert-type scale with possible responses of 1 = Not familiar at all, 2 = Slightly familiar, 3 = Moderately familiar, 4 = Very familiar, 5 = Extremely familiar.⁷

The survey questions are shown in [Table 1](#). The survey responses are detailed in the results section.

Statistical analysis

Curriculum survey results were summarized with descriptive statistics. Pre- and post-course survey results were compared using unpaired *t*-test analysis. All analyses were performed using GraphPad QuickCalcs (GraphPad Software, San Diego, CA).

Results

We distributed anonymous surveys to the residents before and after the completed rotation. Pre-course surveys were completed by seven residents and post-course surveys were completed by 10 residents. Detailed descriptive statistics from the survey and *t*-test results are shown in [Table 1](#).

In brief, the average pre-course mean score was 2.51 and the post-course mean score was 3.84. Each of the seven questions demonstrated a significantly increased post-course mean score from the pre-course. Differences between pre- and post-course scores ranged from 0.61 (question 3) to 2.00 (question 5).

Table 1

Descriptive statistics of pre- and post-course mean scores from resident self-surveys. P-values calculated using unpaired *t*-test. Significance set at $p \leq 0.05$ (*).

Survey Question	Pre-Course Mean	Standard Deviation	Post-Course Mean	Standard Deviation	P-Value
(1) Interpreting the clinical significance of hemostasis and coagulation lab testing	2.86	0.64	3.90	0.54	0.003*
(2) Ordering hemostatic drugs and reversing agents for appropriate reasons	2.71	0.45	3.60	0.80	0.02*
(3) Ordering RBCs, plasma, platelets, and cryoprecipitate for appropriate reasons	3.29	0.45	3.90	0.54	0.03*
(4) Ordering blood product modifications and special products for appropriate reasons	2.43	0.49	3.90	0.54	<0.001*
(5) Ordering emergency release RBCs and activating the massive transfusion protocol for appropriate reasons	2.00	1.07	4.00	0.63	<0.001*
(6) Interpreting the clinical significance of antibody screen results and other pre-transfusion compatibility tests	2.14	0.83	3.60	0.63	<0.001*
(7) Recognizing and managing transfusion reactions	2.14	0.64	4.00	0.45	<0.001*
Total Question Average	2.51	0.65	3.84	0.59	<0.001*

Comment

The addition of the capstone case-based learning simulation adds to our previous work, reflecting changes from three previous iterations of this curriculum based on resident feedback. The problem-based summation session adds real-life practical applications in the form of simulated patient problems, integrating multiple simpler component skills and knowledge into larger and more complex clinical judgments. Previous research in transfusion medicine has shown that simulation-based learning for first-year residents and medical students has been effective in improving overall knowledge of transfusion medicine.⁸

One limitation of our current study is that our data comes from relatively few participants at one institution, making this analysis specific to our institution. The survey responses were completely anonymous and therefore, pretest and posttest answers from a single resident cannot be compared. In addition, there was a noticeable discrepancy in the current number of residents who filled out the pre-course survey (7) and the post-course survey (10). While we strongly encouraged the trainees to participate in the surveys, participation was voluntary. That said, and even with a smaller sample size, the increase in pretest and posttest mean scores demonstrated significance. This supports the premise that the current version of the curriculum is a helpful educational tool.

In evaluating the current version (version 4) of this curriculum, we note that prior assessment surveys were only completed for versions 1 and 2 of the three previous versions (6). The prior survey questions were also broader in scope, when compared to the current survey questions for version 4, focusing on general topics, such as “basic principles of blood products,” “basic principles of pretransfusion testing,” and “basic principles of transfusion reactions.” Moreover, the response options to these questions, “not effective,” “somewhat effective,” and “very effective,” were less nuanced compared to the Likert scale used for current assessment of version 4. Another major difference is that the previous survey was only offered following course completion, without any data collected prior to the course. As the data cannot be compared directly, it is difficult to determine whether the incremental changes incorporated into version 4 were an improvement based on previous iterations.

Perhaps the biggest limitation, which is consistent with our previous publication, is the absence of formal knowledge assessments. An ideal study design would include an assessment of residents over time, perhaps including performance on transfusion medicine board questions and a pretest and posttest on medical knowledge about transfusion medicine.^{9,10} Our primary quantitative metrics here are merely self-reported subjective familiarity using the Likert scoring system.

Two suggestions for future iterations of this course are obtaining post-course knowledge assessments in addition to surveys at later time-points including board exam reports for questions relating to transfusion medicine. Although there is no direct evidence that this final summation

session is an improvement from the previously published curriculum, the implementation of resident feedback from three years along with statistically significant difference in pre-course and post-course survey scores indicate some potential effectiveness of this most recent course version.

In summary, we share our curriculum materials of a simulation session that was designed to integrate and apply concepts that anesthesiology residents learned during their rotation in blood banking. Our hope is that this open access addition to our previous materials can be utilized by learners and trainers.

Author contributions

A.S.H. wrote the supplementary case materials, was the lead instructor during the educational course, and assisted with manuscript preparation. W.N.R. provided input for the capstone case development, helped instruct students during the educational course, and assisted with manuscript preparation. M.R.K. prepared the initial data analysis and wrote the manuscript. A.P.T. revised the manuscript, updated the data analysis, and co-wrote the facilitator guide with A.S.H.

Declaration of competing interests

The authors declare no competing interests.

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Supplementary data

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