

Transfusion Medicine Education for Anesthesiology Residents: A Novel Curriculum

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Abstract

Transfusion medicine education for anesthesiology residents was an unmet need at our institution. Our goal was to develop a detailed and organized curriculum to introduce the essentials of transfusion medicine to first-year anesthesiology residents during a 3-week shared rotation. Based on our observations and the residents' feedback, the curriculum was modified after each year with the goal of creating a more resident-focused educational experience. Here, we report our 3-year experience of creating, teaching, and revising this curriculum to 35 residents, and we share our detailed curricula and learning aids (including over 100 directing questions for reading assignments) so that the interested reader can begin using them immediately.

Keywords

transfusion medicine, blood banking, anesthesiology, graduate medical education, resident, rotation, curriculum

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Introduction

More than 45% of red blood cells are transfused in settings in which anesthesiologists work (www.hhs.gov). Anesthesiologists order more than 50% of blood products in most large hospitals.^{1,2} Across all specialties, most blood product transfusions are administered by physicians without dedicated training in the principles of transfusion medicine (TM).³ Furthermore, TM is listed as part of the examination for board certification in anesthesiology,⁴ and anesthesiology residents (ARs) who train in TM perform better in TM.⁵ To these ends, we were guided by previous work that showed that a structured approach for ARs in TM would improve their medical knowledge, provide an opportunity for them to learn and discuss TM topics with nonanesthesiologists, develop better judgment regarding blood utilization, and improve the safety of transfusions.^{6,7}

This was an unmet need for 2 reasons. One, our institution's anesthesiology residency program director requested a structured learning experience. And two, reports have shown junior residents demonstrate limited knowledge about

complications of blood transfusion and indications for special products like irradiated cellular products among other topics in TM.⁸⁻¹⁰ For the teaching format, previous work showed that teaching TM to undergraduate medical students and first-year ARs through simulation-based learning has been effective in improving TM overall knowledge.¹¹ Finally, the content was modeled after the transfusion medicine academic award program that developed a comprehensive curriculum with goals and objectives for TM teaching in medical schools.¹² To our knowledge, this report is the first one that shares a detailed curriculum for training in TM for ARs in the United States.

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Table 1. Curriculum Version 1.*

	Day 1	Day 2	Day 3	Day 4	Day 5
10 am	Lab session: Tour and observe blood products issuing	Lab session: Antibody screen	Lab session: Antibody ID 1	Lab session: Transfusion reaction workup	Lab session: Antibody ID 2
11 am		Reports sign-out			Reports sign-out
12 pm	Week 1: Overview of coagulation system Week 2: Platelets Week 3: Transfusion reactions: febrile, allergic, and anaphylactic	Week 1: Blood administration Week 2: Platelets refractoriness Week 3: Acute and delayed hemolytic transfusion reactions	Week 1: Red blood cells Week 2: Massive transfusion Week 3: Transfusion associated circulatory overload and transfusion related acute lung injury	Week 1: Plasma and cryoprecipitate Week 2: Perioperative blood management Week 3: Septic transfusion reactions and metabolic complications	
1 pm	Lab session: ABO/D typing	Visit American Red Cross	Lab session: Cross-matching	Audit assignments	

* Three weeks total. Noon sessions include all residents. Other sessions include one-third of the residents at a time.

Materials and Methods

Study Group

The learners are postgraduate year 1 (PGY1) ARs. This rotation was held once per year in 2015 to 2017. For 2 iterations, there were 12 such residents, and 1 year there were 11. The main impetus was from the anesthesiology residency program director, who asked us in TM if we could create a learning experience for them. The time allowed was a 3-week interval that the anesthesiology residency program director had created to be populated by a variety of nonpatient care learning activities for the PGY1s that included classroom and hands-on sessions in anesthesiology, advanced cardiac life support, and mindfulness training as well as capacity for residents to take required exams and other mandatory training. In short, we were presented with and accepted the opportunity to provide one component of this patchwork rotation. We were able to find enough capacity among blood bank and TM staff/trainees to perform the learning sessions, as we viewed this as an opportunity to educate current residents who will be “in the trenches” for almost the next 4 years and who will then be practicing anesthesiologists—including at our own institution—soon after. We created a curriculum, schedule, and learning aids. We revised them after each year’s rotation.

Initial Curriculum

The schedule for the first iteration is shown in Table 1. The complete materials are in Supplement 1. The 2 broad components of the curriculum were large group sessions with all the PGY1s and small group sessions with a third of the residents at a time. The large group sessions were group discussions of study questions based on reading assignments. The residents prepared in advance by answering all the questions for that day’s session using provided reference resources (Table 2). The small groups were used for blood bank laboratory exercises, report sign out, audit assignments, and “conversations” sessions with TM faculty.

Table 2. References in Transfusion Medicine.

- Christopher Hillyer, Beth Shaz, James Zimring, and Thomas Abshire. *Transfusion Medicine and Hemostasis: Clinical and Laboratory Aspects*. 1st edition. Elsevier Science, 2009.
- Online resources
 - Choosing Wisely guidelines
<http://www.choosingwisely.org/wp-content/uploads/2015/02/AABB-Choosing-Wisely-List.pdf>
 - ASA guidelines
<http://www.asahq.org/~media/sites/asahq/files/public/resources/standards-guidelines/practice-guidelines-for-perioperative-blood-management.pdf>
 - Antibody identification
<http://www.austinncc.edu/mlt/bb/AbIdentificationReneeWilkins.ppt>
 - Emergency Release Blood
https://www.pathology.med.umich.edu/bloodbank/manual/bbch_3/index.html
 - Platelets HLA-matching and cross-matching
<http://onlinelibrary.wiley.com/doi/10.1111/j.1537-2995.2007.01126.x/full>
 - Blood administration
https://www.pathology.med.umich.edu/bloodbank/manual/bbch_6/
<http://www.clinlabnavigator.com/blood-infusion.html>
 - Perioperative blood management
<http://www.asahq.org/~media/sites/asahq/files/public/resources/standards-guidelines/practice-guidelines-for-perioperative-blood-management.pdf>

A critical aspect of the large group sessions was that the discussions be resident-led. That is, each session would have 1 to 2 resident leaders to keep the group on track, and the supervising faculty would intervene only to correct misconceptions or answer any additional questions—not to be the source of answers or lecturer.

In addition to these large group discussions that happened 4 times per week (for a total of 12 sessions), we also had small groups of residents (one-third of the residents for 1 week each) do lab sessions (also known as lab exercises or bench work)

Table 3. Audit Assignment.

Learning objective: Given the transfusion record for a surgical case, be able to reconcile the blood utilization in the case with the transfusion guidelines and the clinical scenario.

1. Find your group's patient and date of procedure below.
 - a) Small group 1: Patient's medical record number (MRN) and Date
 - b) Small group 2: Patient's MRN and Date
 - c) Small group 3: Patient's MRN and Date
2. Use the Electronic medical record (EMR) to retrieve data on:
 - a) How many of which products were transfused & when?
 - b) What indications were chosen?
 - c) How they were supported by lab data?
 - d) What other clinical documentation supports the transfusion practice?
3. Write a summary (0.5-2 pages) in which you:
 - a) Summarize data from step 2 above in as easy-to-read a way as you can
 - b) Comment on the appropriateness of transfusions including how strong or weak the clinical data were to support the practice; this commentary should be the bulk of the assignment
 - c) Comment on documentation limitations you encountered and/or opportunities for EMR improvement

with blood bank staff, attend report sign out (ie, antibody, reaction, and standard operating procedure deviation reports) with the pathology resident and TM faculty, visit the blood center, and complete an audit assignment (Table 3). Finally, the residents provided informal comments and completed a postrotation evaluation that we used to revise the curriculum for year/version 2.

Curriculum Version 2

Based on resident feedback that is detailed in the results and discussion sections, version 2 (Table 4) included the following changes. For iteration 2 of the rotation, we deleted the audit assignment, one lab exercise, added 2 hands-on operating room (OR) sessions led by a senior AR, and added 2 “conversations” sessions that highlighted common reasons why a blood bank physician would call the anesthesiologist. The complete materials are in Supplement 2.

Curriculum Version 3

Based on resident feedback that is detailed in the results and discussion sections, version 3 (Table 5) included the following changes. For iteration 3 of the rotation, we consolidated the 12 group sessions into 6. The content remained the same but occurred in fewer sessions. The 2 hands-on OR sessions were consolidated into 1. The lab exercises were deleted except for the first one—the blood bank tour and observation of issuing blood. The complete materials are in Supplement 3.

Curriculum Version 4

Based on resident feedback that is detailed in the results and discussion sections, version 4 (which has not happened yet) is expected to include the following changes. For iteration 4 of the rotation, we will delete the sign out sessions and the blood center tour. Table 6 lists highlights for each curriculum version.

Metrics

We sent each resident an anonymous online survey of questions immediately after the rotation. We did not do a prerotation survey, any knowledge/skill assessments, or a longer term survey.

Results

An anonymous postrotation survey was conducted by ARs after the first iteration of the rotation (Figures 1, 2, and 3). All respondents found the rotation to be effective in helping them learn basic principles of blood products, pretransfusion testing, and transfusion reactions. Additionally, the noon sessions and small group activities (broadly defined) were reported as effective in improving blood bank knowledge and group communication skills.

Another survey after the second iteration was answered by the next year's group of residents (Figures 4, 5, and 6). Similarly, all respondents agreed that the rotation objectives and noon sessions were effective in improving their TM education with some variability depending on the task. Formal postrotation does not exist for iteration 3, but nonsurvey observations and comments were informally collected for iteration 3 as well as previous iterations.

Discussion

The structure of the curriculum was limited by 3 practical constraints. One, the curriculum is structured during selected dates and times over a 3-week period because this larger rotation is a hodgepodge of activities and topics—only one of which is TM. Second, this TM rotation is intended as an introduction to TM rather than a comprehensive one or one that emphasizes the latest updates. We were inspired by work that has shown that learners should first be taught the essential discoveries in the field and should be taught them in hierarchical order with the goal concept formation and first-handed independent thinking.¹³ To that end, the main learning objective is to learn the basics of blood products, pretransfusion compatibility testing, and transfusion reactions. Third, a key scheduling constraint was that all of the PGY1 ARs (usually 12) would rotate simultaneously during this 3-week period once per year.

Thus, we were not necessarily able to do—nor should we do—what we normally do for pathology residents, which is to provide the resident with direct experiential learning via “called first” clinical responsibilities in all areas of the TM service with the corresponding hands-on training and

Table 4. Curriculum Version 2.*

	Day 1	Day 2	Day 3	Day 4	Day 5
10 am	Lab session: Tour and observe blood products issuing	Lab session: Antibody screen	Lab session: Antibody ID	Lab session: Transfusion reaction workup	Common conversations with transfusion medicine faculty 2
11 am		Reports sign-out			Reports sign-out
12 pm	Week 1: Overview of coagulation system Week 2: Massive transfusion Week 3: Hands-on OR	Week 1: Red blood cells, irradiation, leukoreduction, and CMV-safe products Week 2: Perioperative blood Week 3: Hands-on OR	Week 1: Plasma and cryoprecipitate Week 2: Transfusion reactions: febrile, allergic, and anaphylactic Week 3: Transfusion associated circulatory overload and transfusion related acute lung injury	Week 1: Platelets Week 2: Acute and delayed hemolytic transfusion reactions Week 3: Septic transfusion reactions and metabolic complications	
1 pm	Lab session: ABO/D typing	Visit American Red Cross	Lab session: Cross-matching	Common conversations with transfusion medicine faculty 1	

Abbreviation: CMV, cytomegalovirus.

* Three weeks total. Noon sessions include all residents. Other sessions include one-third of the residents at a time.

Table 5. Curriculum Version 3.*

	Day 1	Day 2	Day 3	Day 4	Day 5
11-12 1:30	BB tour	Sign out Visit Red Cross	ALL	ALL	Sign Out

Abbreviation: BB, blood bank.

* Three weeks total. Wednesday and Thursday sessions include all residents. Other sessions include one-third of the residents at a time.

supervision by TM faculty. With that limitation, we chose to construct an experience that attempted to maximize both resident engagement and TM faculty/instructor time efficiency. An implication of this goal for resident engagement was a decision made early on that this would be lecture-free because, as the senior author's mentor eloquently stated, "I don't think that residents need *more* lectures."

On the one hand, we were unable to provide the optimal experiential learning via clinical responsibilities. And on the other hand, the senior author had a notion that lectures fail to compete with naps and computerized devices. Thus, the decision was made to utilize primarily a resident-led discussion format with minimal facilitation by faculty.

Version 2 was informed by comments that residents seemed to not gain much by the relatively academic and impractical audit assignment and that there were too many lab exercises. The 2 hands-on OR sessions led by a senior AR were added due to a request for more practical skills in the OR setting. Finally, we added the 2 "conversations" sessions due to our own notions that they would benefit from simulated interactions with a TM physician in contexts that are common for TM-anesthesiology clinical conversations.

Version 3 was informed by comments that residents finished each large group session very early and requested a consolidation rather than having so much downtime upon finishing early. Also, several residents reported that the degree of detail that was explored in the other lab exercises was not terribly relevant to their practice. Similarly, some residents reported that the sign-out sessions could be decreased or eliminated, but we kept these in version 3 with the rationale that it is useful for them to see how these reports are generated. In retrospect, at that time, we were engaging in information overload given the limited time, and we had a misconception that what works well for pathology residents should work well for ARs.

The biggest change from 2 to 3 was deleting the lab sessions. After much reflection, we realized 2 important reasons why we should delete the lab exercises (except the tour/issuance of blood session). One, ARs will never need these skills in their practice. That is, we should not try to train ARs to become TM physicians or blood bank staff with that level of detail in every concrete technical bench task. Two, many residents stated that the key concepts of immunohematology and transfusion reactions were already covered adequately in the large group sessions' study questions. Thus, further detail and reinforcement had significantly diminishing returns.

The remaining single lab session that includes a blood bank tour and observation of issuing blood has 2 primary purposes. One, it "breaks the ice" between the blood bank and the resident. That is, I claim that based on my observations, the physical entrance into the blood bank goes a long way toward demystifying the workings of the blood bank. Two, this interaction provides a 2-way humanizing of both blood bank staff and ARs. In other words, I claim that these simple introductions and putting of faces to names and voices in an unrushed

Table 6. Curriculum Version Highlights.

Version	Group Sessions	Lab Sessions	Sign Outs	Blood Center Tour	Audit	Conversations	Hands-on OR
1	12	7	2	1	1	0	0
2	12	6	2	1	0	2	2
3	6	1	2	1	0	0	1
4 (TBD)	6	1	0	0	0	0	1

Abbreviation: TBD, to be determined.

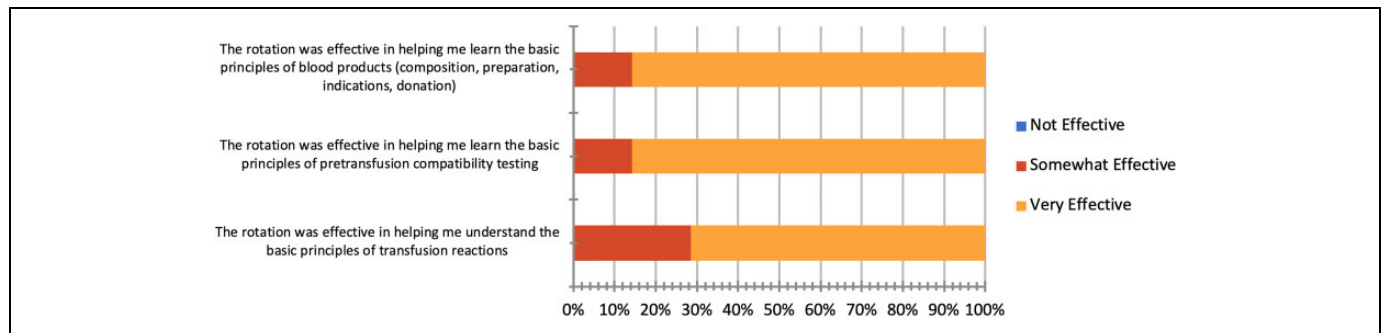


Figure 1. Evaluation of effectiveness of rotation objectives (n = 7) for curriculum (version 1) reported by percentage.

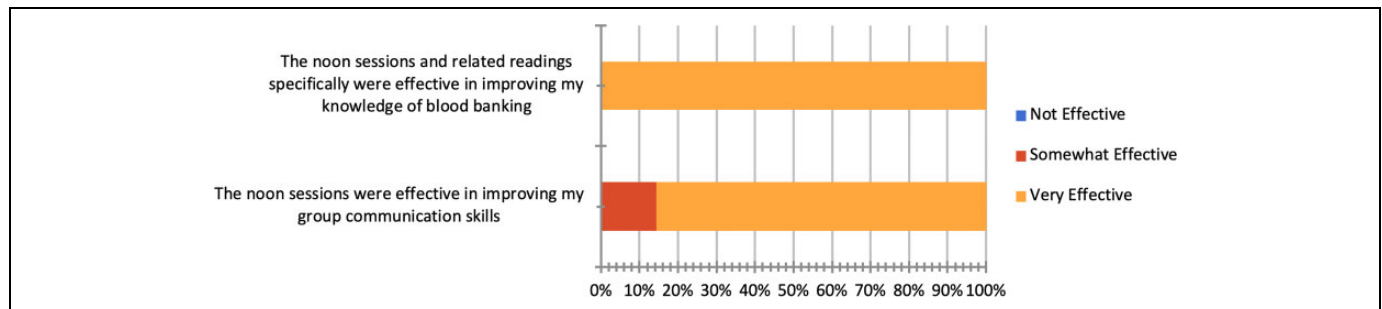


Figure 2. Evaluation of effectiveness of noon sessions (n = 7) for curriculum (version 1) reported by percentage.

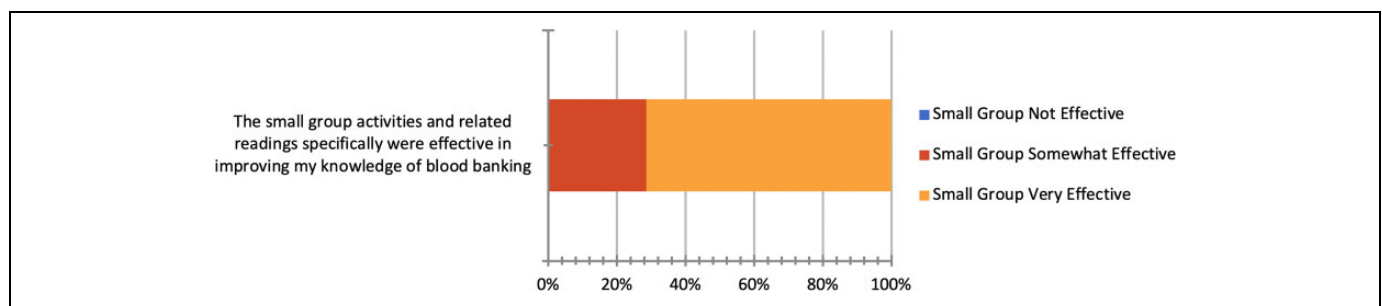


Figure 3. Evaluation of effectiveness of small group (n = 7) for curriculum (version 1) reported by percentage.

constructive environment helps to plant seeds of mutual goodwill and shared goals that will likely make future conversations more collegial and less contentious. In sum, seeing who and what is physically in the blood bank from “the other side” and seeing every step of what is needed in order to issue blood products is likely to increase understanding and empathy.

Version 4 is the most updated curriculum, and iteration 4 has not happened as of this writing. Version 4 will likely not

include the sign-out sessions or the blood center tour. Many residents reported that these were not optimal uses of their time—mainly for reasons of too much detail, not enough direct relevance to anesthesiology, and not enough active learning or hands-on responsibility. Unlike the pathology residents, the ARs do not have direct responsibility in writing the reports. Thus, ARs were forced to be relatively passive observers during sign-out sessions. Also, the details of report construction

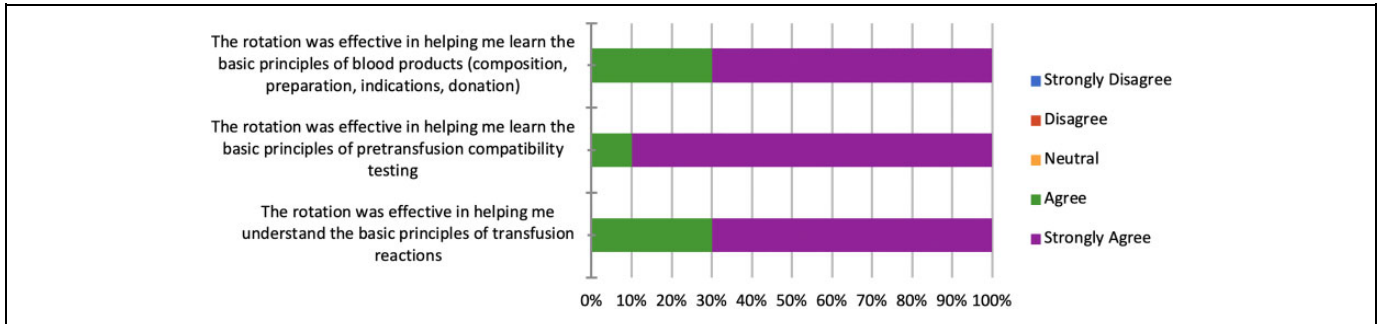


Figure 4. Evaluation of effectiveness of rotation objectives ($n = 10$) for curriculum (version 2) reported by percentage.

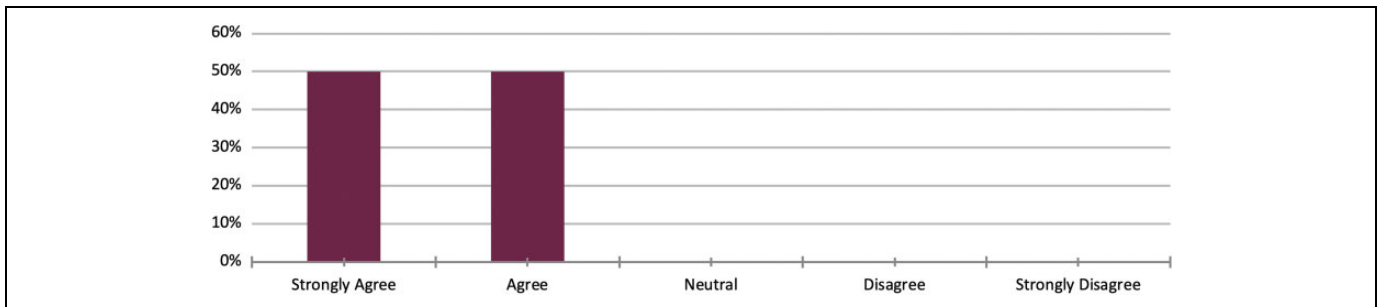


Figure 5. Evaluation of effectiveness of noon sessions ($n = 10$) for curriculum (version 2) reported by percentage.

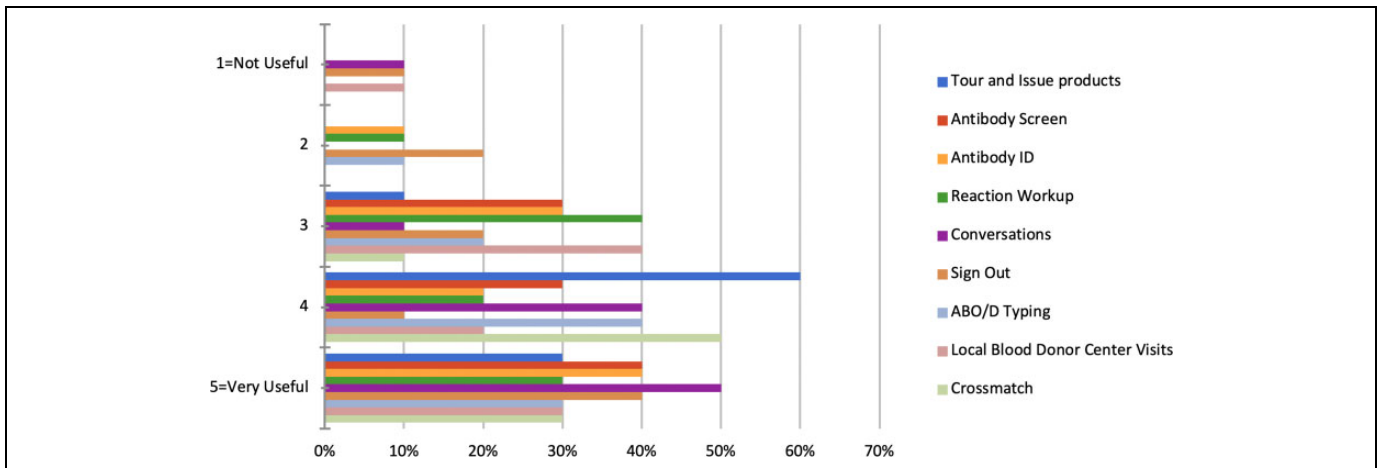


Figure 6. Evaluation of usefulness of small group activities ($n = 10$) for curriculum (version 2) reported by percentage.

and nuances of technical details were not seen as high-yield information for anesthesiology practice. Finally, the tour was positively received overall and appreciated, but many residents commented that it was not an efficient use of time compared to self-study or other more active tasks.

One limitation is the limited scope and duration of the formal resident surveys, as iteration 3 data are not available. Perhaps the biggest limitation is the absence of a formal knowledge assessments. An ideal study would include an adequately powered analysis of resident performance on TM topics on the board exam over time, a pretest and posttest on medical knowledge and practical task performance, and a

comparison of TM-specific milestone evaluations over time. We have not created nor have direct access to these data, so they are not included here. Our main metrics—loosely defined—are self-reported subjective satisfaction comments and informal observations by the curriculum writer. Thus, this report does not claim to be authoritative or even expertly effective. We share it as a modest first step that may assist graduate medical education programs elsewhere to create and implement a curriculum that will effectively train ARs in TM.

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Supplemental Material

Supplemental material for this article is available online.

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