

Original Publication

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# Thrombotic Microangiopathy Team-Based Learning Module for Second-Year Medical Students

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## Abstract

**Introduction:** Thrombotic microangiopathy (TMA) syndromes are a diverse group of disorders characterized by microangiopathic hemolytic anemia (intravascular hemolysis and presence of peripheral blood schistocytes) and thrombocytopenia. Prompt diagnosis is crucial to inform management and improve patient outcome. Clinical and laboratory manifestations of these various disorders overlap, making diagnosis difficult. My colleagues and I developed a team-based learning (TBL) module for second-year medical students in their hematology course block. **Methods:** Students attend a 1-hour lecture on hemolytic anemia in their standard course curriculum and are given two articles to read outside of class in preparation for the TBL. Total out-of-class preparatory time is 30 minutes. The TBL runs for 1 hour, and students participate in groups of eight. Materials associated with this TBL include the lecture on hemolytic anemia, individual and group readiness assurance test questions, and application exercises. Explanations for all answers are provided for instructors. **Results:** Surveys indicated students enjoyed the TBL and felt that after participation, their ability to diagnose a TMA was improved. They felt that the number of questions in the session was appropriate to time allowed and that the preparatory articles provided a sufficient level of understanding to participate in the TBL. Some commented they would have liked more time to complete the application exercises, so instructors could consider increasing the allotted time to 1.5 hours. **Discussion:** Based on the success of this TBL, we plan to develop additional modules for the course and investigate other measures of academic success after implementation.

## Keywords

Team-Based Learning, Anemia, Hematology, Thrombocytopenia, Hemolytic Anemia, Thrombotic Microangiopathies, Hemolytic

## Appendices

- A. Hemolytic Anemia Lecture .ppt
- B. Session Learning Objectives.docx
- C. IRAT & GRAT.docx
- D. Application Exercises.docx

*All appendices are peer reviewed as integral parts of the Original Publication.*

## Educational Objectives

By the end of this team-based learning module, learners will be able to:

1. Describe the pathophysiology of thrombotic microangiopathy (TMA), specifically thrombotic thrombocytopenia purpura (TTP) and atypical hemolytic uremic syndrome.
2. Identify the general clinical and laboratory manifestations of TMAs.
3. Use clinical clues and laboratory data to differentiate between TMAs of pregnancy.
4. Identify the appropriate treatment of familial and congenital TTP.
5. Identify the treatment options for TMAs of pregnancy.

## Introduction

Team-based learning (TBL) is an evidenced-based teaching format that shifts instruction from a traditional lecture-based teaching paradigm to a structured learning sequence that includes individual student preparation outside of class followed by active, in-class problem-solving exercises completed by student learning teams.<sup>1</sup> TBL was introduced as a medical education strategy in 2001 and has shown promise in improving learner outcomes such as examination performance and learner satisfaction.<sup>2</sup>

In the past several years, the medical school curriculum at the University of Florida College of Medicine has undergone a major overhaul to move from a traditional lecture-based format to one that incorporates elements of the flipped classroom and problem-based learning techniques. This has been done with measures of success ranging from improved student performance to increased satisfaction. Based on the importance of pattern recognition and on the success of case-based learning and teamwork in the field of hematology, my colleagues and I created a TBL module for implementation in the second-year medical student hematology course block. This course covers topics in both malignant and nonmalignant hematology. Given my interests and clinical background, a TBL examining a topic in nonmalignant hematology was created.

The thrombotic microangiopathy (TMA) syndromes are a diverse group of disorders characterized by microangiopathic hemolytic anemia (intravascular hemolysis and the presence of peripheral blood schistocytes) and thrombocytopenia. Varying degrees of neurologic and renal function, along with other organ involvement, can also be seen. Because approach to the management of TMA syndromes can differ, prompt diagnosis is crucial. These diagnoses are complicated by the often overlapping clinical and laboratory features. This overlap lends itself nicely to interdisciplinary discussion and learning about these disorders in a team-based format.

This module is one of several case-based modules the students participate in, although it is the only one following the formal TBL criteria. In other sessions in the course, students participate in labs, allowing them to work through cases either individually or in a group, based on their preference. While this is a nice departure from the standard lecture-based curriculum, we were interested in implementing a more formal TBL format in our course. Review of MedEdPORTAL and other existing TBL opportunities for use in the field of nonmalignant hematology showed a relative paucity of relevant TBL material, so we believe the current resource is a welcome addition to the educational literature. Students performed well in this novel TBL and reported satisfaction with its implementation. We hope to build on this success with the development and implementation of other TBL modules and to explore and investigate other learning outcomes beyond improvement in test scores as that improvement is often influenced by many parameters.

## Methods

### Team Formation

At our institution, medical students are placed into collaborative learning groups (CLGs) of eight students each via a computerized system that utilizes demographic and prior training information, allowing for the creation of diverse groups. Students remain in their groups for all small-group learning activities during their medical school training. Studies have demonstrated that team sizes larger than six lose cohesion. Although we use a group size of eight students for our purposes, we recommend about five to seven students per group to maintain cohesion.

### Description of Advance-Preparation Resources

Prior to participation in this TBL, students attend a 1-hour didactic lecture titled “Hemolytic Anemia” (Appendix A) as a part of the standard curriculum for the MS2 Hematology course. This introductory lecture covers the differential diagnosis and basic diagnostic approach to a patient with hemolytic anemia. TMAs, a form of hemolytic anemia, are introduced in this lecture. The lecture is given the week prior to the TBL session. Following the lecture, TBL session learning objectives (Appendix B) and two short preparatory articles<sup>3,4</sup> are distributed via email 1 week ahead of the in-class TBL activities. In the Townsley article,<sup>4</sup> students are asked to read only the section “Preeclampsia/HELLP.” Total advance preparatory time outside of the classroom is approximately 30 minutes to 1 hour.

### Description of Readiness Assurance Process

On the day of the TBL, students arrive at class and are asked to sit in their CLGs. Our classroom is equipped with multiple circular tables; this greatly enhances group learning. Students are asked to put away all learning materials other than their laptops or tablets. The individual readiness assurance test (IRAT; Appendix C) is then posted live to Canvas, an online educational hosting software utilized by many

of our faculty and course directors for quizzes and assignments. Students enter their responses to the multiple-choice questions online directly into the Canvas system. We utilize an online system because, in our course, the student's IRAT score counts as a course quiz grade and makes up a small proportion of the final grade. If an online system is not available or desired, IRATs may be printed on paper and distributed or projected on a central screen, and answers may be recorded in an alternative fashion. After 7 minutes, the IRAT is closed electronically by our class administrator, and students are no longer able to submit or alter answers.

#### Immediate Feedback

Following the IRAT, students complete the same multiple-choice questions together in their groups as part of the group readiness assurance test (GRAT; Appendix C). We implement the immediate feedback-assessment technique (IF-AT) using IF-AT cards ordered from Epstein Educational Enterprises ([www.epsteineducation.com](http://www.epsteineducation.com)). These answer cards feature a thin opaque film that covers the answer choices for each question. Students scratch off answers much as one would scratch off a lottery ticket. If the answer is correct, a small star or symbol appears underneath, indicating that the student has selected the correct answer. In this way, learning is immediately reinforced. Each group receives one scratch-off card and is given 11 minutes to complete the GRAT. We then review the cards and record the responses to the GRAT portion of the TBL in order to compare the individual and group responses.

After completion of the GRAT, students are given time to share any pressing questions they have. In addition, they are informed of their right to appeal any answer they feel represents a better choice. In our experience, no students have questions at this point in the process, and no group or student has ever filed an appeal.

#### Description of Team Application Activities

After the IRAT and GRAT, groups participate in the team-based application exercise (Appendix D). These case-based questions are intended to move from "What do I want students to know?" at the start of the TBL to "What do I want students to be able to do?" with that knowledge. Students are presented with two separate case-based stems, each involving a patient presenting with symptoms and laboratory findings consistent with a different TMA. Some questions focus on what additional laboratory information students would need to solidify a particular diagnosis, while others ask students to differentiate between clinical characteristics of different TMAs. This subject matter is complex as many TMAs have overlapping features, which results in a hearty and educational discussion amongst groups, making this an excellent topic for TBL.

#### Facilitation Schema

This particular TBL is short given course time constraints and encompasses only an hour. Students have generally felt this was enough time for completion, although several have commented that 1.5 hours would be preferable. We allow 20 minutes for completion of the IRAT and GRAT combined and focus the bulk of our time on the group facilitation of the application exercises. The overall facilitation schema is as follows:

- 20 minutes allotted for IRAT and GRAT.
  - 7 minutes for IRAT.
  - 11 minutes for GRAT.
  - Brief 2-minute check-in to ensure no major conceptual holes remain after preparatory assignments or readiness assurance test questions.
- 40 minutes allotted to group application exercise.
  - 20 minutes devoted to each of two cases.

#### Results

A total of 140 second-year medical students participated in the TBL and were organized into 17 groups, as described in the Methods section. This was a novel addition to our MS2 Hematology curriculum. Based on student evaluations and end-of-course test results, this module will be used again as we develop a rolling TBL curriculum for our course.

As is expected in the TBL framework, GRAT scores showed a significant improvement from IRAT scores. The readiness assurance tests consisted of 5 multiple-choice questions derived from the students' preparatory materials. On questions one through five, the percentage of students answering correctly was 90.7% ( $n = 127$ ), 98.6% ( $n = 138$ ), 98.6% ( $n = 138$ ), 71.4% ( $n = 100$ ), and 83.6% ( $n = 117$ ), respectively. Groups answered all of the questions correctly on the first attempt, with the exception of question four, which one group answered incorrectly on its first attempt but correctly on the second attempt. The student responses to the application exercises provided a wealth of opportunity for interteam discussion. While the majority of groups answered correctly (approximately 75% for each answer choice), the number of incorrect responses to each question provided an opportunity for teams to teach one another why specific answers had been chosen and opened a space for multiple teaching points.

After completion of this TBL, students were given a hyperlink to a voluntary online survey using Qualtrics software to assess their overall satisfaction with the learning experience. Students were asked questions about the quality of the preparatory materials, the number of questions administered, and whether they felt more prepared to help diagnose a TMA after their TBL experience. They were also asked to comment on what they enjoyed about the TBL and how to improve its impact. Forty-six of our 140 students participated in this survey, although not all participants answered all questions. Of the respondents, 81.6% ( $n = 31$ ) agreed that the reading assignments and lecture prepared them for the TBL, while 10.5% disagreed; 86.5% ( $n = 32$ ) felt that the number of questions in this TBL was "just right," whereas 10.8% ( $n = 4$ ) felt there were "not enough" and 2.7% ( $n = 1$ ) felt there were "too many." Furthermore, 67.6% ( $n = 25$ ) felt more prepared to help diagnose a TMA after the TBL, while 16.2% ( $n = 6$ ) reported that they did not.

Students were invited to share what they enjoyed about the TBL. Representative comments included "I enjoyed the challenging questions," "I learned a lot and liked that we got it all done in the one hour that was allotted," and "I think the questions were great practice for actual clinical medicine, not just a test." Commentary on areas of improvement included allowing more than 1 hour for the activity (students suggested 1.5-2 hours) and providing a summary sheet of comparisons between the various TMAs discussed in the TBL.

## Discussion

Having a working knowledge of the differential diagnosis for TMA and understanding the basic diagnostic workup are important for all health care practitioners. While our TBL was created with the intent to educate medical students, it may also be used to educate other learners in the health care field such as nursing or physician assistant students. This TBL is also a useful teaching tool in the education of internal medicine and family medicine housestaff. In addition, we are planning to build added complexity into this session for use in the education of our hematology/oncology fellows.

For this present iteration, preparatory materials include a lecture that is part of the course curriculum and two brief reading assignments. Students spend approximately 1 hour preparing for this session outside of class. As expected when using a team-based format, teams performed better than individuals. This in and of itself is an important learning point for students participating in these learning exercises as the practice of medicine is one that requires teamwork and collaboration. Scores on the individual testing indicated that students were generally well prepared for this learning activity. However, the fact that so many students performed so well on the readiness assurance tests suggests that the questions may not be sufficiently challenging; in the future, we intend to increase the complexity of the questions to enhance critical thinking. For the most part, students enjoyed this activity, as gleaned from post-TBL surveys. They felt that this format was conducive to learning about a complex array of disorders that often overlap in terms of their clinical and laboratory manifestations. Some students felt that more time to complete the exercise would be helpful. While our course allowed for only 1 hour to be dedicated to this TBL, it would likely have felt less rushed and permitted more detailed discussion with more time. In the future, we hope to be able to devote more than a single hour, which will allow for a less hurried pace and more in-depth case and content development. Based on our student feedback, we suggest that educators using this TBL allow approximately 1.5 hours.

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**Ethical Approval**

Reported as not applicable.

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