Original Publication

OPEN ACCESS

Flipped Classroom Module on Shock for Medical Students

Jennifer A. Hoffmann, MD*, Rachel W. Thompson, MD

*Corresponding author: Jennifer.Hoffmann@childrens.harvard.edu

Citation: Hoffmann JA, Thompson RW. Flipped classroom module on shock for medical students. *MedEdPORTAL*. 2017;13:10542.

https://doi.org/10.15766/mep_2374-8265.10542

Copyright: © 2017 Hoffmann and Thompson. This is an open-access publication distributed under the terms of the Creative Commons Attribution-NonCommercial-Share Alike license.

Abstract

Introduction: This module teaches medical students about shock through a flipped classroom approach. By the conclusion of the module, students are able to differentiate the main types of shock, recognize clinical signs of shock, and formulate initial treatment plans. The flipped classroom approach means that students complete the lower levels of cognitive work (gaining knowledge and comprehension) outside of class, so that they can focus on the higher forms of cognitive work (application, analysis, synthesis, and evaluation) in class with the support of their peers and instructors. **Methods:** Prior to class, students complete advance preparation by reading selected articles. In class, students work through case-based discussion questions in teams. **Results:** This module has been successfully implemented, with survey data from students showing higher self-rated confidence in their ability to achieve specified objectives after completion of the module. According to survey data, students felt they learned more from the class than from a traditional lecture format, and the class promoted teamwork skills. **Discussion:** This module provides a tool for pediatric faculty instructors to redesign a traditional lecture-based class on shock into an interactive, case-based session that uses the flipped classroom approach.

Keywords

Sepsis, Shock, Emergency Medicine, Anaphylaxis, Case-Based, Pediatrics, Flipped Classroom

Appendices

- A. Objectives and Preparatory Resources.docx
- B. Instructions for Class.docx
- C. Cases and Discussion Questions.docx
- D. Scoring Sheet.docx
- E. Answer Key.docx
- F. Pre- and Postclass Surveys .docx

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

Educational Objectives

By the end of this module, the learner will be able to:

1. Define shock from a pathophysiologic standpoint.
2. Differentiate and give examples of the four main types of shock: hypovolemic, cardiogenic, obstructive, and distributive.
3. Distinguish between systemic inflammatory response syndrome, sepsis, severe sepsis, septic shock, and multiple organ dysfunction syndrome.
4. Recognize the clinical and laboratory features of septic shock.
5. Recognize the clinical features of anaphylactic shock.
6. Identify common triggers of anaphylaxis.
7. Formulate initial plans for the treatment of septic and anaphylactic shock.
8. Collaborate with peers, using teamwork skills to arrive at shared clinical decisions.
9. Practice self-directed learning, including identification of knowledge gaps.
10. Apply clinical reasoning skills in the analysis of and application of evidence-based clinical guidelines to a case.

Introduction

This module is designed for third-year medical students on their pediatric clerkship to learn about shock through a flipped classroom approach. By the conclusion of the module, students are able to differentiate

the main types of shock, recognize clinical signs of shock, and formulate initial treatment plans. The content area of shock was selected for several reasons. First, early recognition and appropriate management of shock are critical to avoiding adverse outcomes, due to the high mortality rate of the disease process. Second, basic knowledge about shock is universally important for all doctors, not just pediatricians. In fact, one of the core entrustable professional activities endorsed by the Association of American Medical Colleges that medical students should be able to perform by the time of graduation is the ability to recognize a patient requiring urgent or emergent care and to initiate evaluation and management.¹ Finally, since teamwork is essential to the management of shock in the clinical setting, it makes sense for students to also learn about shock in a team setting, so that they can more easily translate the skills learned to future clinical care.

In the flipped classroom approach, students are expected to complete advance preparation prior to class. At our institution, students are given the option of reading articles or viewing videos available via the Khan Academy. The time in the classroom is then used to reinforce concepts through problem solving and discussion. The theoretical foundation for the flipped classroom relies on Bloom's taxonomy. If students complete the lower levels of cognitive work (gaining knowledge and comprehension) outside of class, they can focus on the higher forms of cognitive work (application, analysis, synthesis, and evaluation) in class with the support of their peers and instructors. The flipped classroom helps students to organize their new knowledge so that it is more accessible for future use.²

Prior educational research has provided evidence for the effectiveness of the flipped classroom. Mazur and Crouch developed a form of the flipped classroom that they termed *peer instruction*, in which students gained first exposure prior to class and used in-class time for discussion of conceptual questions. Students enrolled in peer instruction courses at Harvard University exhibited learning gains ranging from 0.49 to 0.74 over 8 years of assessment. Two introductory physics classes taught by traditional methods during the assessment period at Harvard showed much lower learning gains (0.25 in a calculus-based course in 1990 and 0.40 in an algebra-based course in 1999).³ Thus, the flipped classroom has been shown to increase learning when compared to more traditional teaching methods.

Deslauriers, Schelew, and Wieman also demonstrated that flipping the classroom can produce significant learning gains. Midway through the semester, one section of a large physics class was flipped, with first exposure to new material occurring prior to class via reading assignments and quizzes. Class time was devoted to small-group discussion of questions and active-learning exercises, with no formal lecture included in the experimental group. At the end of the experimental week, students completed a multiple-choice test, resulting in an average score of $41\% \pm 1\%$ in the control classroom and $74\% \pm 1\%$ in the flipped classroom, with an effect size of 2.5 standard deviations.⁴ The dramatic increase in student learning supports the use of the flipped classroom format that has been applied in this module for medical students to learn about shock.

Methods

For implementation of the module, session objectives and preparatory resources (Appendix A) are distributed to students 1 week ahead of the classroom activities. Students are asked to read two journal articles from *Pediatrics in Review* on shock and anaphylaxis.^{5,6} These articles are written at an appropriate level for the learners, and the estimated time to read them is 30 minutes. If this module is to be adapted for use at an institution that does not have access to *Pediatrics in Review*, alternative articles from the *New England Journal of Medicine* and *American Family Physician* (both of which are available online without an institutional subscription) are listed in the references.^{7,8}

Upon arriving at the class, the instructor reviews the format of the class with the students and passes out a set of instructions (Appendix B). Students are asked to form teams of four students. Each student in the team takes on one of four roles: leader, reader, scribe, or information seeker. The leader is responsible for keeping the team on task, including time management, and has the final say when team members disagree on the proposed answer. The reader reads the case aloud to the group and reveals answers from the key. The scribe writes down the team's answers and tallies points earned. The information seeker

has a laptop available to reference electronic resources. A suggested set of clinical guidelines are the Children's Hospital of Philadelphia clinical pathways for sepsis and anaphylaxis.^{9,10}

Students are asked to work through a series of case discussion questions (Appendix C) using peer teaching and knowledge sharing, drawing on the content learned during the preclass work. For each question, the scribe records the answers generated by the team on the scoring sheet (Appendix D). After recording an initial answer, the team may use electronic resources, including the suggested evidence-based guidelines, to modify its answer. As the answers are revealed from the key (Appendix E), students should give themselves full credit for correct answers generated by the team alone and half credit for answers generated through the use of electronic resources. The instructors circulate around the classroom to answer any questions that may arise from the discussion.

Pre- and postclass surveys (Appendix F) are used to evaluate the module. The preclass survey is distributed electronically and completed prior to the advance-preparation work. The postclass survey is completed at the end of class.

The suggested time frame for the class is 60 minutes, with 10 minutes for review of the instructions and division into groups, 40 minutes for the group activity, and 10 minutes to complete the postclass survey.

Results

The module has been implemented for two classes of 20 third-year medical students on their pediatric clerkships. The module was delivered by a third-year pediatric resident, with support from the pediatric clerkship director, who is trained in pediatric emergency medicine.

The module has been evaluated through the use of pre- and postclass surveys. The first part of the survey assessed the ability of the module to meet the content objectives. Students were asked to self-report their confidence in their ability to achieve each learning objective on a 5-point Likert scale (*not confident* to *completely confident*) before and after the module was completed (Table 1). A chi-square test (Fisher's exact test with two-tailed *p* values) was used to compare students who rated themselves as *very* or *completely confident* with those who rated themselves as *not*, *slightly*, or *moderately confident* before and after the module was completed. The data show statistically significant improvement in self-reported confidence in meeting each of the content objectives after completion of the module (*p* < .001 for all objectives). For several of the objectives, 100% of students reported feeling *very* or *completely confident* in their ability to perform the objective after the module.

Table 1. Percentage of Students Rating Themselves as Very or Completely Confident in Their Ability to Meet the Stated Learning Objective (N = 41)

Learning Objective	Percentage of Students		
	Preclass	Postclass	<i>p</i> Value ^a
Understand the pathophysiologic definition of shock.	61	100	<.001
Differentiate types of shock.	33	98	<.001
Distinguish between systemic inflammatory response syndrome, sepsis, severe sepsis, septic shock, and multiple organ dysfunction syndrome.	53	98	<.001
Recognize the clinical and laboratory features of septic shock.	64	98	<.001
Formulate initial plans for the treatment of septic shock.	31	100	<.001
Recognize the clinical features of anaphylactic shock.	53	100	<.001
Formulate initial plans for the treatment of anaphylactic shock.	47	100	<.001

^aStatistically significant difference using chi-square test (Fisher's exact test with two-tailed *p* values).

The second part of the survey questioned students about the learning format and delivery of the module (Table 2). Students were asked to rate their agreement with several statements on a 5-point Likert scale (*strongly disagree* to *strongly agree*). Based on the data, most students (97%) found the preparation materials to be helpful. The majority (73%) of students felt that the time spent in preparation prior to class was appropriate. Students spent a range of 0-40 minutes in preparation for class, with an average time of 23 minutes. The majority (88%) of students enjoyed this type of class more than a traditional lecture, and 88% felt they learned more from this type of class than from a traditional lecture. All students felt that this type of class promoted teamwork skills.

Table 2. Percentage of Students Agreeing or Strongly Agreeing With Statements Regarding the Learning Format (*N* = 41)

Statement	Percentage of Students Agreeing or Strongly Agreeing
The preparation materials were helpful.	97
The time spent in preparation prior to class was appropriate.	73
The instructions provided regarding the format of the class were clear.	89
The time frame for the class was adequate.	85
I enjoyed this type of class more than a traditional lecture.	88
I learned more from this type of class than a traditional lecture.	88
This type of class format promoted teamwork skills.	100
I found it useful to practice applying guidelines to a clinical case.	83

The postclass survey also solicited open-ended comments or suggestions regarding the class. Students commented that the class was fun, interactive, and a more effective method of learning compared to a standard lecture. Students liked the assigned roles and the student-driven nature of the class. They stated that it was helpful to work in teams to answer questions.

The format of the class has been adjusted based on the initial feedback received from the students. In the first implementation of the class, students were instructed not to access electronic resources or view the answer key until they had worked through all of the questions together as a team. In the second implementation, the format was modified to the current approach described, in which students are allowed to access resources and review the answer key immediately after attempting each question as a team. This has improved the flow of the class and allows students access to more immediate feedback on their answers.

Discussion

This module illustrates the successful use of a flipped classroom approach to teach medical students about shock. At our institution, two options for preclass preparation (Khan Academy videos and written articles) were provided to accommodate the preferences of different types of learners. The cases were chosen to highlight the most important concepts in the recognition and initial management of shock, and questions were designed to allow students to integrate basic science knowledge from the first and second years of medical school. The class was generally well received by the medical students, with survey data showing that students rated themselves as more confident in their ability to achieve the module's content objectives upon completion of the class. According to the survey data, students felt that they enjoyed the flipped classroom more than a traditional lecture, learned more from this type of class format, and were able to utilize teamwork skills in class.

The assessment of the module was limited by self-reported survey data. In the future, a more rigorous knowledge-based assessment could be developed to assess how effective the module is at meeting the learning objectives. The effectiveness of this class could also be compared in a randomized fashion to a traditional lecture on shock. Based on the overall success of the module, the flipped classroom approach could be extended in the future to other topic areas covered during the medical student clerkship. The module could also be adapted for use in a capstone course for fourth-year medical students who are preparing for an intern year in pediatrics.

Jennifer A. Hoffmann, MD: Fellow in Pediatric Emergency Medicine, Boston Children's Hospital

Rachel W. Thompson, MD: Assistant Professor of Pediatrics, Boston Medical Center

Disclosures

None to report.

Funding/Support

None to report.

Ethical Approval

Reported as not applicable.

References

1. Englander R, Aschenbrener CA, Flynn T, et al. Core Entrustable Professional Activities for Entering Residency. iCollaborative Web site. <https://www.mededportal.org/icollaborative/resource/887>. Posted May 28, 2014. Accessed July 20, 2016.
 2. Brame CJ. Flipping the classroom. Vanderbilt University Center for Teaching Web site. <http://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom>. Published 2013. Accessed March 21, 2016.
 3. Crouch CH, Mazur E. Peer instruction: ten years of experience and results. *Am J Phys*. 2001;69(9):970-977. <https://doi.org/10.1119/1.1374249>
 4. Deslauriers L, Schelew E, Wieman C. Improved learning in a large-enrollment physics class. *Science*. 2011;332(6031):862-864. <https://doi.org/10.1126/science.1201783>
 5. Yager P, Noviski N. Shock. *Pediatr Rev*. 2010;31(8):311-318. <https://doi.org/10.1542/pir.31-8-311>
 6. Langley EW, Gigante J. Anaphylaxis, urticaria, and angioedema. *Pediatr Rev*. 2013;34(6):247-257. <https://doi.org/10.1542/pir.34-6-247>
 7. Vincent J-L, De Backer D. Circulatory shock. *N Engl J Med*. 2013;369(18):1726-1734. <https://doi.org/10.1056/NEJMra1208943>
 8. Arnold JJ, Williams PM. Anaphylaxis: recognition and management. *Am Fam Physician*. 2011;84(10):1111-1118.
 9. Balamuth F, Funari MK, Lavelle J, et al. ED pathway for evaluation/treatment of infants > 28 days of age and children with severe sepsis. Children's Hospital of Philadelphia Clinical Pathways Web site. <http://www.chop.edu/clinical-pathway/severe-sepsis-clinical-pathway-infants-28-days-age-and-children>. Published July 2011. Updated June 2015. Accessed February 12, 2016.
 10. Lee J, Brown-Whitehorn T, Tsarouhas N, et al. ED pathway for evaluation/treatment of children with anaphylaxis. Children's Hospital of Philadelphia Clinical Pathways Web site. <http://www.chop.edu/clinical-pathway/anaphylaxis-clinical-pathway>. Published June 2006. Updated October 2014. Accessed February 12, 2016.
-

Received: October 24, 2016 | **Accepted:** January 15, 2017 | **Published:** February 13, 2017