

Original Publication

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A Case of Pancreatic Cancer: Abdominal Anatomy Team-Based Learning Module for Medical Students

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Abstract

Introduction: Team-based learning (TBL) is an instructional method utilized by the University of Alabama School of Medicine to facilitate collaboration and integration of concepts introduced in undergraduate medical training. This TBL was created for the Gastrointestinal module and facilitates understanding of anatomy of the retroperitoneal space, posterior abdominal wall, and neurovasculature of the abdomen. This module integrates topics from abdominal anatomy, radiology, and clinical decision-making for medical students. **Methods:** Prior to the TBL, students were provided with a set of learning objectives and three instructional video podcasts. During the in-class portion of the activity, learners completed the readiness assurance phase, which consisted of individual and team assessments. During the application phase, teams of five to six students collaborated on multiple-choice questions centered on the presentation, diagnosis, surgical intervention, and palliation of a patient with pancreatic cancer. TBL sessions were cofacilitated by an anatomist and a physician. **Results:** Since the TBL's institution in 2014, medical students have consistently performed better on the readiness assurance test in teams rather than individually. On a 5-point Likert scale, over 90% of students in the 2016 ($M = 4.12$) and 2017 ($M = 4.20$) Gastrointestinal modules agreed or strongly agreed on an end-of-course evaluation that the TBL activity was effectual for learning. **Discussion:** In a medical climate that continues to rely heavily on cross-sectional imaging, early integration of gross anatomy and cross-sectional anatomy is essential and can facilitate acclimation to the clinical years. This TBL would be a valuable addition to other undergraduate medical programs.

Keywords

Team-Based Learning, Abdomen, Pancreatic Cancer, Gross Anatomy, Radiology, Pancreatic Neoplasms, Whipple

Appendices

- A. Learning Objectives.docx
- B. RAT Instructor Guide.docx
- C. tRAT Student Version.docx
- D. Application Exercises Instructor Guide.docx
- E. TBL Session Presentation .pptx

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

Educational Objectives

By the end of this activity, learners will be able to:

1. Describe the three-dimensional anatomy of the posterior abdominal wall and retroperitoneal space.
2. Explain the vascular supply and nervous innervation to the abdominal cavity.
3. Apply anatomy to the diagnosis and treatment of gastrointestinal/abdominal pathologies.

Introduction

This team-based learning (TBL) activity was developed as part of the Gastrointestinal (GI) module, which is a 6-week course in the second semester of the preclinical curriculum at the University of Alabama School of Medicine (UASOM). The GI module is the third organ system module in the one-pass, organ system-based preclinical curriculum at the UASOM, following in sequence the Cardiovascular and Pulmonary modules.¹ The GI module integrates a number of basic science disciplines, including gross anatomy, embryology, histology, physiology, pharmacology, microbiology, pathology, and radiology. Content is delivered through a variety of instructional approaches, including traditional lecture, vodcast (i.e., video podcast), cadaveric dissection, TBL, small-group case-based learning, histology laboratory, pathology laboratory, interactive game, and simulation. Three formative assessments are conducted during weeks 2, 4, and 5; two summative assessments are conducted in weeks 3 and 6.

Within the GI module, medical students receive instruction on the gross anatomy and radiology of the abdominal cavity through lectures, vodcasts, three cadaveric dissections, two TBL exercises, a computed tomography (CT) radiology small-group exercise, and a hands-on ultrasound session in which students perform an ultrasound of the gallbladder and a FAST (focused assessment with sonography in trauma) exam. Anatomical instruction in both the lecture and cadaveric laboratory settings is provided by a core group of experienced, PhD-trained anatomists, and radiologic instruction is provided by clinical faculty from the Department of Radiology. Because the two TBL activities offer a unique opportunity to integrate gross anatomy with radiology and clinical practice, these sessions are cofacilitated by an anatomist and a physician, either a radiologist or a general surgeon. Each anatomy facilitator is an experienced TBL facilitator who leads the session. Physician cofacilitators provide clinical insight and answer clinical questions that arise during the activity.

This TBL activity was developed to aid students in applying knowledge of the GI tract, posterior abdominal wall, and abdominal neurovasculature to the diagnosis and treatment of abdominal disease. Each application exercise is based upon a single patient diagnosed with pancreatic cancer, which allows students to follow the patient through clinical presentation, radiologic examination, surgical intervention, and palliative care. Pancreatic cancer was selected because it provides an opportunity to engage students in discussions of the retroperitoneal space, posterior abdominal wall, abdominal neurovasculature, and the relationship between the biliary system, pancreas, and duodenum. The activity was first introduced in March 2014 and has been used each year since.

The final three application exercises focusing on palliative care via a celiac plexus nerve block have been included in a previous publication designed for physician assistant and nurse anesthesia students.² However, in this TBL activity designed for medical students, we have greatly expanded upon these application exercises to align with medical student learning needs: diagnosis, imaging, and treatment of abdominal disease. Here, we present a patient with pancreatic cancer and allow students to follow the patient through clinical presentation, diagnostic imaging, surgical treatment, and palliative care. While other publications in *MedEdPORTAL* have presented TBL exercises designed to facilitate medical students' learning and clinical application of anatomy,³⁻⁷ to our knowledge this is the first to do so with the abdomen as its focus.

Methods

Curricular Context

The UASOM class size is 186 students. This TBL activity was conducted during the first week of the GI module. It was the second TBL of the GI module and the sixth anatomy TBL of the preclinical curriculum. Prior to the GI module, first-year medical students had been instructed in anatomy of the anterolateral abdominal wall and had been introduced to the abdominal cavity contents in the Fundamentals of Medicine course in their first semester. Two anatomy TBLs were held in the first week of the GI module to provide more detailed instruction and application of abdominal anatomy and radiology. The first TBL was designed to highlight anatomy of the abdominal viscera and included two cases: a patient with a liver laceration requiring surgical intervention and a patient with alcoholic liver and pancreatic disease. The current TBL was designed to highlight anatomy of the posterior abdominal wall, retroperitoneal space, and abdominal neurovasculature.

Team Formation

At the UASOM, entering medical students are organized into 32 teams by the Introduction to Clinical Medicine (ICM) course staff. While these teams are primarily formed for clinical skills training in the ICM course sequence, students carry out a number of learning activities within their team, including all TBL exercises, cadaveric dissections, and small-group case-based learning activities. To form teams, students

are initially grouped based on their campus assignment—medical students are assigned at the time of admission to one of four campuses where they will complete clinical training in years 3 and 4. Then, students are randomly placed into the 32 teams. Teams range in size from five to six persons and remain unchanged throughout the 4 years of medical school.

Because of the UASOM class size, all TBL exercises in the preclinical curriculum are conducted with one-third of the total class (10-11 teams) at a time. This reduction in the total number of students present in a TBL activity room provides a larger number of opportunities for students to speak aloud and answer questions during the interteam discussions. For this activity, three concurrent TBL sessions were held. Each was cofacilitated by an anatomist and a physician.

Description of Advance Preparation Resources

At the beginning of the GI module, 4 days prior to the in-class TBL session, students were provided a list of objectives for the TBL (Appendix A). A reading assignment from chapter 2 of *Clinically Oriented Anatomy*, seventh edition,⁸ was given as advance preparation for the TBL session. While the total length of this reading assignment was 89 pages, a large portion of the assignment was redundant with the first GI TBL exercise since *Clinically Oriented Anatomy* intermingles descriptions of anatomy of the GI viscera with neurovasculature of the abdomen.

Description of Readiness Assurance Process

Students completed the 10-item individual readiness assurance test (iRAT; Appendices B & E) at the beginning of the TBL activity. The iRAT was synchronously administered using TurningPoint, an audience response system; students were given 75 seconds to answer each question. Subsequently, teams completed the same 10-item assessment as the team readiness assurance test (tRAT). Hard copies of the tRAT were passed out to each group (Appendix C). Immediate Feedback Assessment Technique (IF-AT) cards (available from www.epsteineducation.com) were used for the tRAT portion to provide immediate feedback to learners. The RAT was designed for IF-AT card E027. Partial credit was awarded on the tRAT as 50% credit for correct responses on the second attempt and 10% credit for the third attempt. No credit was awarded for correct answers given on the fourth or fifth attempt. Questions making up the RAT were selected to correspond to the advance preparation study objectives (Appendix A) and assessed students' baseline mastery of required prematerial. The iRAT and tRAT were closed-book assessments. Final TBL grades were determined by an equally weighted average of the iRAT and tRAT scores.

Following the RAT assessments, students were permitted to ask questions of the facilitators and receive additional clarification on test items or content for which uncertainty remained. This period, commonly known as a mini-lecture, was restricted to approximately 5 minutes. Formal RAT item appeals were not conducted.

Description of Team Application Exercises

The team application exercises within this TBL activity were structured as eight multiple-choice questions presented at specific points during an unfolding case study of a patient diagnosed with pancreatic cancer (Appendix D). The application exercises followed the 4S criteria: significant problem, same problem, specific choice, and simultaneous reporting.⁹ The application exercises and associated unfolding case study were presented to students via PowerPoint (Appendix E). Students were encouraged to use a variety of resources to help answer application exercise questions, including notes, textbooks, and the internet. Following intrateam discussion of questions, simultaneous reporting was conducted through students holding up colored letter cards. Cofacilitators then mediated interteam discussion of each question. Students were not evaluated during the application exercise.

Facilitation Schema

The TBL exercise was designed for a single, 110-minute educational session. A suggested facilitation time line is given below.

- Welcome and learning objectives (2 minutes).
- iRAT (13 minutes).
- tRAT (15 minutes).
- Mini-lecture (5 minutes).
- Application exercises (75 minutes).

Evaluation

The perceived overall effectiveness of the TBL activity was evaluated through a 5-point Likert scale item on the end-of-course student evaluation each year. Student mastery of learning objectives was measured through performance on the RAT assessments. TBL as an instructional method at the UASOM was further evaluated through an instructional methods research study that has been published.¹⁰

Ethical Approval

This study was deemed not human subjects research by the University of Alabama Institutional Review Board for Human Use.

Results

First-year medical students enrolled in the GI module between years 2014-2017 ($n = 749$) participated in this TBL exercise. Quantitative data were collected each year on the session as a whole through course evaluations and also on student performance on the RAT portion of the exercise. Here, we report data from the 2016 and 2017 classes.

Mean iRAT scores were 74.8% and 76.1% for the 2016 and 2017 classes, respectively. Individual iRAT items ranged in difficulty values from 0.11 (very difficult) to 0.99 (very easy; Appendix B). The literature has shown that mean iRAT scores should correlate with performance on summative assessments,¹¹ which was observed for this iRAT. Mean tRAT scores were 98.5% and 99.7% for the 2016 and 2017 classes, respectively. Each year of implementation, we observed a similar increase between mean iRAT and tRAT scores, demonstrating that students performed better in teams than individually on the assessment.

At the conclusion of the GI module, students completed an end-of-course evaluation of the TBL activity as part of the overall course evaluation. On a 5-point Likert scale, 91% of students in the 2016 ($M = 4.12$) and 92% of students in the 2017 ($M = 4.20$) GI modules agreed or strongly agreed that the activity was effectual for learning. As an instructional approach at the UASOM, TBL was recently evaluated along with seven other pedagogies.¹⁰ On a 5-point Likert scale, medical students rated TBL higher than any other instructional method ($M = 4.20$). Peer evaluations were not conducted in the GI module.

Discussion

This TBL exercise provided medical students with an opportunity to apply factual knowledge of anatomy to a clinical case and to integrate three-dimensional anatomy with cross-sectional anatomy as seen in clinical CT. The use of TBL in medical education has been shown to provide short-term knowledge gains in anatomy^{12,13} and other basic science disciplines.¹⁴ With over 90% of students rating the activity as effectual for learning, this TBL is considered an important component of the GI module.

The modern clinical practice of medicine often relies heavily upon radiologic imaging, although the ways in which radiology is taught in medical school vary.^{1,15-17} We included a significant medical imaging component in this TBL so as to provide students with opportunity to develop skills in interpreting radiographic images. A key factor in the success of this TBL activity's implementation was the presence of

clinical faculty able to facilitate discussions of the relevant radiology and clinical interpretation. We have found that cofacilitation of the TBL by both an anatomist and a radiologist or surgeon is very effective for integrating the basic and clinical sciences.

For the RAT, students performed well on most items. Furthermore, high mean scores on the tRAT indicate students were capable of appropriately synthesizing information to correctly answer these items when working in a team, which is a core goal of the TBL pedagogy.¹⁸ Four items were rewritten after implementation, however, due to poor item performance or to conform better with best practices in test item writing. Both the original items and revised items are included in Appendix B.

Overall, teams of medical students were able to correctly answer most of the application exercise questions, and students enjoyed this phase of the TBL. While all questions had some incorrect team responses, the item most commonly missed and therefore deemed most difficult was application exercise item 5. A considerable amount of time was spent on interteam debate over this item. A greater length of time was also devoted to discussion of item 2 and the identification of relevant anatomy within the CT images. While other basic science disciplines such as embryology and histology were not included in this TBL, new application exercises could be integrated into the clinical case to bring in these related disciplines. For example, interpretation of pathology results from the fine-needle aspiration biopsy (FNAB) could be included as a means of bringing histology of the pancreas into the TBL activity. As the TBL continues to be implemented within the GI module, it will be constantly evaluated to ensure its best fit within the overall curriculum. While no plans exist at present to modify the TBL, potential changes or improvements in the future may include the incorporation of FNAB and histology of the pancreas as well as the potential incorporation of physiology of the pancreas and how pancreatic cancer disrupts normal organ functioning. Another possible area of expansion for the TBL is in the area of palliative care. This TBL is rife with opportunity to discuss varying options for palliation of care as well as the costs and benefits for quality of life.

Limitations

While we lack data to formally evaluate knowledge gains that may have been achieved through the use of this TBL exercise, the high student evaluation of the activity supports its success and continued use in the curriculum. One limitation of the activity is a lack of item performance data on the revised readiness assurance items 1, 3, 6, and 10. These items were edited postimplementation to conform to best practices in item writing (items 1, 3, and 10) or because of poor item performance (item 6) and thus have not been utilized in their revised form. Another limitation of this TBL exercise in the context of its use at the UASOM is a high demand for faculty time. Three anatomy facilitators and three physician cofacilitators spend a total of 12 hours implementing the TBL plus additional time in preparation. This represents a significant investment of faculty time.

In summary, this TBL exercise was designed to provide instruction to medical students in the anatomy of the abdominal cavity. Through integration of gross anatomy and radiology, the TBL engaged students in clinical application of anatomy relevant to the retroperitoneal space, posterior abdominal wall, and abdominal neurovasculature. This TBL would be a valuable addition to other medical curricula to enhance the vertical integration of clinical sciences into the preclinical years of training.

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Ethical Approval

Reported as not applicable.

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