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Introductory TBL Exercise on Genetic Risk

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*Corresponding author: vpark@uthsc.edu**Abstract**

Introduction: Team-based learning (TBL) has gained favor in medical education as an applied approach to learning that promotes teamwork and communication and has been an integral component of the University of Tennessee Health Science Center medical school curriculum since 2011. This module is intended to serve as an introduction to team-based learning (TBL) for students learning basic principles of medical genetics. **Methods:** This was developed to be completed in a 1-hour class period. Using a single case scenario, students are asked to evaluate risk for two conditions: autosomal recessive and X-linked recessive. The exercise provides experience in calculating disease risk based on family history. Additionally, students have the opportunity to reflect on a family's perceived risk and burden of genetic disease. **Results:** The exercise was developed for underserved students attending a summer program prior to the start of medical school in the fall who had no prior TBL experience and no advanced expertise in medical genetics. Across three administrations, facilitators of this TBL module have consistently observed positive student engagement during the various components of the TBL. **Discussion:** This TBL module has served its purpose well by providing early learners an exposure to the TBL format in solving genetic risk calculations. Since the resource conforms to standard TBL format, it can be readily implemented in traditional TBL classrooms.

Keywords

TBL, Pedigree, X-Linked Recessive, Autosomal Recessive, Genetic Risk, Genetic Disease

Educational Objectives

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

1. Construct a pedigree, given a family history.
2. Use appropriate reading resources about a specific disorder to evaluate the pedigree and to predict risk for Mendelian diseases (autosomal recessive and X-linked recessive).
3. Consider and discuss social and family issues that may be relevant to a case scenario, including individual perceptions of risk and disease burden.
4. Practice fairness and respect for the opinions of team members and strive for a common goal of putting the needs of the patient first.

Introduction

Team-based learning (TBL) has gained favor in medical education as an applied approach to learning that promotes teamwork and communication^{1,2} and has been an integral component of the University of Tennessee Health Science Center medical school curriculum since 2011. This TBL exercise has been delivered three times during an intensive summer program for underserved students who are slated to begin medical school in the fall. The TBL module serves as an introduction to the mechanics of TBL and a preview of the regular medical school curriculum. Additionally, it provides an opportunity for early learners to practice problem solving, a core competency for medical genetics.³ In addition to calculating risk estimates, an effort is made to illustrate the relevance of risk information to patients. The motivation for development of this resource was to enhance student preparedness and confidence by providing exposure to content and pedagogy that will be encountered in the regular curriculum.

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Appendices

- A. Genetic Risk iRAT.pptx
- B. Genetic Risk tRAT.docx
- C. Genetic Risk RAT-Facilitator .docx
- D. Genetic Risk Application-Learner.docx
- E. Genetic Risk Application-Facilitator.docx

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

Comparable resources are available for students on MedEdPORTAL with more background in medical genetics and when longer class periods (e.g., 2 hours) are available.^{4,5} MedEdPORTAL also hosts an additional resource that includes genetic risk as part of discipline-specific content relating to neurological diseases.⁶

Methods

A number of excellent resources describing standard TBL methods are available.^{1,2,7,8} Unless indicated otherwise, standard methods were used in this resource.

Team Formation

Standard TBL methods recommend that team formation be conducted by the facilitator in a random and transparent manner.^{1,9} Although standard methods for team formation are followed in our medical school curriculum, since this specific TBL was a onetime experience for summer students, temporary teams were used. Our summer student cohorts varied in size but were always small, and each year's group was divided into two equal teams by asking seated students to count off for assignment to either team 1 or team 2. Over 3 years, team sizes have ranged from three to six students.

Description of Advanced Preparation Resources

Students should be familiar with the Hardy-Weinberg equation.¹⁰ They will need to be able to use this equation to calculate carrier frequency when disease incidence is given and vice versa.

Students should also be familiar with the basic principles of Mendelian disease risk. Information on this may be found on the Genetics Home Reference Web site.¹¹ We recommend that under the Handbook: Help Me Understand Genetics page of this site, the topics of inherited genetic conditions, genetic consultation, and genetic testing be reviewed, as should the newborn screening page in the Web site's Glossary. The conditions of MCAD deficiency and Lesch-Nyhan syndrome under Conditions should also be reviewed through the first four sections. With regard to MCAD deficiency, facilitators may emphasize to students during the TBL that although the symptoms of MCAD deficiency may be complex, a primary risk in affected infants is sudden death and that this risk can be managed through appropriate nutrition and avoidance of fasting.

Description of Readiness Assurance Process

The Individual Readiness Assurance Test (iRAT; Appendix A) is delivered using PowerPoint. Questions are projected on a screen one at a time, and students' responses are not displayed. Although the iRAT may be delivered as a paper quiz, we have found the use of an audience response system (Turning Technologies, Youngstown, OH) to be equally effective. At the completion of the iRAT, students repeat the same questions as part of a team during the administration of the Team Readiness Assurance Test (tRAT; Appendix B). Each team uses Immediate Feedback and Assessment Technique (IF-AT) cards to record their answers. Both of the Readiness Assurance Test (RAT) components in this module are abbreviated, consisting of only two questions rather than the more typical five to eight questions. This maximizes time for the Application Exercise (Appendix D) and allows for delivery of the entire resource in 1 hour. The RAT questions target skills crucial to successful completion of the Application Exercise questions.

Since, in our context, this is the students' first exposure to TBL, it has improved time management to have one facilitator per team explain the procedure for using an IF-AT card at the beginning of the tRAT. In implementation, since we had only two teams per session, the facilitator and the teaching assistant have served this purpose successfully. In using this resource elsewhere, students' level of familiarity with TBL will be an important factor in planning the session. Experienced TBL students should have no trouble completing the exercise in 1 hour, but inexperienced students will benefit from presession training in TBL and careful time management during the session.

Immediate Feedback

IF-AT cards provided immediate feedback during the tRAT. Although students are not permitted to use any reference materials or assigned readings during the RATs, they may refer to these resources after completion of the tRAT and during the subsequent Application Exercise. Additionally, the facilitator should

answer any lingering questions and provide additional requested feedback to ensure preparedness for the Application Exercise. Facilitators should also remind students that the concepts covered in the RATs will be revisited in the Application Exercise. To assist the facilitator in discussing the RATs, an answer key and rationale for each RAT question are provided in the RAT-Facilitator document (Appendix C). This document also contains the appropriate IF-AT form used during the tRAT.

Description of Team Application Activities

The Application Exercise meets the 4S criteria: Teams work on the *same, significant* problem; each team makes a *specific* choice from those provided; and teams reveal their choices *simultaneously* by holding up colored, laminated cards bearing the letter of their answer choice. The Application Exercise is based on a fictitious case of a young couple with a family history of genetic disorders and consists of four multiple-choice questions. The exercise includes two risk calculations, a competency expected to be learned in the summer program. The other two questions ask teams to consider the impact of genetic risk on a family.

The summer students receive no instruction in genetic counseling, genetic testing and screening, or clinical decision-making other than the assigned introductory reading on the Genetics Home Reference Handbook Web site. Thus, these additional two questions are intended to allow students to reflect on how families might perceive risk and how an understanding of risk can inform clinical decision-making. In other words, the intention is to illustrate relevance of genetic risk calculations. To assist the facilitator in discussing the items after each one is administered, an answer key and rationale for each question are provided in the Application-Facilitator document (Appendix E).

Facilitation Schema

- Overview (5 minutes): This may be omitted if the class is familiar with TBL. It may be extended if procedures and the use of IF-AT cards must be explained.
- iRAT (5 minutes).
- tRAT (10 minutes).
- Application question 1 (15 minutes): Instruct students to complete question 1. Direct the reveal, and facilitate discussion of question 1. More time is allotted for this question, as directing this first reveal may take additional time.
- Application questions 2-4 (20 minutes): Instruct students to complete each of the remaining three questions, directing a simultaneous reveal and facilitated discussion for each question.
- Total time = 55 minutes.

Results

This resource is formatted for a standard TBL classroom. Since we use it as an introductory activity, we accommodate our students' lack of TBL experience in its delivery. Facilitators provide concise instructions at each stage of the exercise. For example, when instructing students to proceed to the next question, they are reminded to work as a team. We also have a facilitator for each of our two teams in order to introduce the use of IF-AT forms. One facilitator is a faculty member experienced with TBL, and the other is a teaching assistant with 1 year of TBL experience as a student. The TBL exercise contributes to the overall goal of our summer program by providing an experiential orientation to our medical school curriculum. While the brief nature of this exercise contributes to its effectiveness as an introductory TBL experience, its format is appropriate for those already trained in TBL. Detailed explanations of each element of the TBL are included both here and in the facilitator documents (Appendices C & E). Our experiences with implementation and delivery are summarized below.

With regard to the RATs, in our regular curriculum, students receive an individual grade for their iRAT and a team grade for the tRAT. However, summer students do not receive grades for this exercise since its primary purpose is TBL orientation and since the grading algorithm for the summer program is based solely on exam grades. In spite of a lack of quantitative data, empirical observations over 3 years suggest that the RAT has successfully achieved its goals. The faculty facilitator and teaching assistants have consistently observed peer teaching taking place during the tRAT. IF-AT cards have documented high

performance on the tRAT, with almost all teams choosing the correct answer as their first response. Student engagement was observed as high during the tRAT, and even this brief experience set the tone for continued interactive teamwork during the Application Exercise.

The Application Exercise includes four multiple-choice questions designed to allow students to practice pedigree construction and risk calculation and to reflect on the relevance of genetic risk information to patients. As with the tRAT, student engagement was evident during the Application Exercise. Although students lacked medical knowledge about the diseases present in the family and about how testing might be carried out, their natural empathy for the family's risk provided sufficient impetus for thoughtful consideration during the reflection questions. The Application Exercise was not graded. Over three summers, two dozen students have completed the TBL. Although no formal evaluation was conducted, students were appreciative of the early exposure to TBL.

Discussion

This TBL module has served its purpose well by providing early learners an exposure to the TBL format in solving genetic risk calculations. The flow of the exercise and, particularly, time management have improved, but no revisions have been made to the module during the 3 years it has been in use. Since summer students received TBL training during their first week of medical school, this experience was treated more like a preview and did not include separate TBL training. However, since the resource conforms to standard TBL format, it can be readily implemented in traditional TBL classrooms.

In our context, limitations of the exercise stem from the small class size, the use of temporary teams, and students' lack of TBL experience. An additional limitation is that there has been no formal evaluation of the program or follow-up with the students, given the difficulty of assessing the impact of a 1-hour experience on a small sample. In a larger sense, evaluation of the entire summer program overall (as opposed to the experiences of this one TBL) has been difficult since we lack a comparison group for what is arguably our most at-risk group of students.

Despite these limitations, we see this TBL exercise as providing a confidence-building advantage to this group of potentially at-risk students, since they will already have TBL exposure when they are placed on permanent teams in the fall. The small class size and the involvement of an experienced facilitator help to overcome the students' lack of TBL experience. A caveat to use in other settings is that while it is a relatively simple matter to guide two teams through their first TBL, this approach is unlikely to be successful in a large class of TBL novices where more structured instruction in TBL would be indicated. In a large class with prior TBL experience, the exercise can be completed in 1 hour.

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Ethical Approval

Reported as not applicable.

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