Medical Science Educator (2021) 31:7–9
https://doi.org/10.1007/s40670-020-01130-9

INNOVATION

Quick and Clean: LCME Scientific Method Training Without a Teaching Laboratory

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Accepted: 15 October 2020 / Published online: 22 October 2020

Abstract

This exercise satisfies the Liaison Committee on Medical Education Standard 7.3 for medical student training in the scientific method. The students are challenged, individually and in small groups, to state and test hypotheses based on real patient data concerning risk factors for the development of hepatocellular carcinoma.

Keywords Standard 7.3 · TBL · Education odds ratio · LCME accreditation · Medical education scientific method · LCME Standard 7.3 · Education hypothesis testing

The ability to state a clear, testable hypothesis and to design an experiment with the power to disprove it is foundational for scientific endeavors of all kinds. The necessity of imparting this skill to future doctors is reflected in Standard 7.3 of the Liaison Committee on Medical Education (LCME), requiring that "The faculty of a medical school ensure that the medical curriculum includes instruction in the scientific method …" [1].

At SUNY Upstate Medical University, to give our students practice with hypothesis testing, we developed an interactive exercise inspired by Team Based Learning (TBL) methodology [2]. (For the full text of the exercise, see Appendix.) Like classic TBL, this exercise combines individual prework, assessment, and small-group work to create learner accountability for mastering the content. In our case, the students, having previously learned about odds ratios and common risk factors for cancer, had to demonstrate the ability to state a hypothesis about risk factors for the development of hepatocellular carcinoma and then test their hypothesis by applying odds ratio calculations to published patient data.

The Scientific Method exercise took place during a second-year Gastrointestinal system unit; basic epidemiology and biostatistics had been introduced 14 months prior. The exercise consisted of an individual Prework assignment (hypothesis-stating and review of the odds ratio calculation), Narrative Feedback from the lead instructor (RG) on the prework prior to the in-person session, and a 30-min class session that included one Individual task (testing the hypothesis by performing an odds ratio calculation on provided patient data), two Small Group tasks (comparing results and discussing further questions with peers), and one Large Group overview (drawing conclusions and imagining future studies). Importantly, the numbers that the students used to calculate odds ratios and test their hypotheses were actual patient data taken from a published study of hepatocellular carcinoma [3]. Before the in-class exercise, the students received only numerical data from the paper. Key points for review, including information needed to locate the original manuscript, were posted to the course website immediately after the exercise. Note that this exercise was not classical TBL, because the Prework and Individual Readiness Assurance Test (IRAT) were merged, and because evaluation and narrative feedback

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were provided on the IRAT rather than the Group Readiness Assurance Test. Providing narrative feedback on the merged PreWork/IRAT underscored the importance of stating a cogent hypothesis and provided an opportunity for students who were confused to refocus their thinking before the group session began.

SUNY Upstate Medical University underwent LCME reaccreditation in 2019. Faculty members who met with the accreditation survey team were able to discuss many other ways in which our institution satisfied Standard 7 ("curriculum provides content of sufficient breadth and depth" [1]), including an innovative new case-based bioethics and public health course [4]. However, when the survey team inquired about scientific method training, they did specifically mention student-generated hypotheses and testing based on real-world data. They were interested to learn about this exercise, which is the only session at Upstate that clearly meets all of the criteria of Standard 7.3. Scientific method training was noted to be satisfactory in the preliminary and final accreditation reports. The authors believe that this session is new and innovative; online searches for comparable existing teaching sessions with Google Scholar, MedEdPORTAL, PubMed, Scopus, and Embase returned physical exam-based approaches [5, 6] and one major curricular overhaul [7].

Students who completed the second iteration of the exercise in 2020 provided feedback afterward. Two-thirds of respondents reported that the exercise enhanced their understanding of the learning objectives (response rate 0.34 (58/170), 62% chose "agree" or "strongly agree"). About one-quarter were neutral on the measure. Among the negative comments, the most common theme (8/21) did not concern the learning objectives, but rather the inconvenience of attending the class session in person. In future years, we will respond by moving the session online.

Acknowledgments The authors gratefully acknowledge the patience and skill of the SUNY Upstate Medical University Undergraduate Medical Education Office support staff, particularly Colleen Denniston and Ashley Scott. Dr. Lauren Germain and Joanna Suser from the SUNY Upstate Medical University Office of Evaluation, Assessment, and Research made helpful contributions. We also thank our former unit coordinator Jennifer Pinkel and reference librarian Sarah Lawler.

Availability of Data and Material Free on request
Code Availability N/A

Compliance with Ethical Standards

Conflict of Interest The authors declare that there is no conflict of interest.

Appendix. Hepatocellular carcinoma/scientific method exercise

A. Learning Objectives:

1) Apply the basic principles of hypothesis testing to data from patients with liver diseases.
2) Cite common risk factors for contracting liver diseases and for suffering poor outcomes.

B. Prework/IRAT:

1) Prompt the class to review the concept of an odds ratio and how to calculate one. Give them the data from [3] pertaining to Hepatitis B and Hepatitis C virus infections in patients with HCC vs control patients, and ask how much of a risk hepatitis virus infection represents for HCC.
2) Divide the class into thirds and ask each third to submit a hypothesis about the risk represented by one of three non-virus factors: alcohol consumption, smoking, and comorbid diabetes.

C. Narrative Feedback:

1) Review the students' odds ratio calculations and prompt them to re-learn the concept, as necessary.
2) Review the students' hypotheses and prompt them to improve their logic or clarity, as necessary.

D. Class Session/GRAT:

1) Provide each third of the class with the data from [3] that pertains to their hypothesis (ie, the data pertaining to alcohol consumption, smoking, or comorbid diabetes alone). Prompt them to individually use the data to test their hypothesis, or to state what additional data would be needed to properly test it.
2) Prompt the class to form small groups including members from each third, so that each group has access to the entire data set. Prompt them to compare hypotheses and conclusions.
3) Challenge each group to answer additional questions together: In this study, which risk factor was the most strongly predisposing for HCC? Which was the second-strongest? If you knew that some patients had multiple risk factors, what would you hypothesize about the magnitude of their HCC risk? What is another hypothesis that you could propose concerning these patients, and what data would you need to test it?
4) Share the groups' answers to the challenge questions with the whole class for discussion.

E. After-Class Review of Key Points:

1) Post the correct answers for the odds ratio calculations.

2) Post additional related points concerning HCC, epidemiology, and biostatistics, indicating which points are important for the course exam, and which are important for the Step 1 exam.

The handouts for the Class Session and the odds ratio calculations and Key Points for Studying for After-Class Review are available from the corresponding author on request.

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