Integrating Case Studies into a Pre-medical Curriculum

Shawn K. Stover, Department of Biology & Environmental Science,

Davis & Elkins College, 100 Campus Drive, Elkins, WV 26241

Abstract: Previous research has indicated that the use of case studies is effective for promoting critical thinking, enhancing interest in curricular content, and improving student understanding of core concepts. To prepare students for the challenges of a medical education, the biology faculty at a small, liberal arts college attempts to expose undergraduates to as much clinically relevant content as possible. Clinical cases are used extensively in several courses available to pre-medical biology majors. Here, the integration of clinical cases into three different courses: a 100-level physiology course, a 200-level histology course, and a 300-level biochemistry course is described. The case study method has proven to be extremely flexible. It can be utilized as a laboratory activity, a homework assignment, or an in-class discussion activity.

Key Words: Case study, pre-medical education, problem-based learning

Introduction

Curricular research on undergraduate science and medical education has emphasized the importance of independent learning and problem solving (Burgess et al., 2014; Freeman et al., 2014). In problem-based learning, students often work in teams, pooling their information and insights in order to solve a problem. Groups of students tend to solve problems better than individuals, especially when the groups are diverse and the individual members have some degree of autonomy (Herreid, 2009).

Groups of students working toward a common goal are often the norm when using case studies as a teaching tool. By requiring careful analysis of evidence by a group of students, case studies promote critical thinking (Herreid, 2004). Furthermore, case studies can make abstract content more relevant to group members, enhancing their interest in the subject matter (Gallucci, 2006). Finally, while working through cases, students are encouraged to consider comments and suggestions from all members of the group. The ability to view concepts from new and different perspectives can improve student understanding of essential course material (Smith & Murphy, 1998).

The incorporation of case studies into a course or curriculum can take many forms. A "directed" case study is designed to encourage critical thinking while enhancing student understanding of a specific concept (Cliff & Curtin, 2001). The case is usually accompanied by several relevant questions that students are required to answer. This type of case might also be considered "closed-ended," meaning all the questions have definite correct answers, and all the information students need to answer the questions is easily accessible in textbooks, lecture notes, and/or online resources (Cliff & Nesbitt, 2005). Students may complete the case analysis during class or on their own time. They may work on the case independently or in groups. This type of activity might also be developed into an "interrupted" case study. In an interrupted case, the instructor provides information in segments, allowing students to propose strategies for analyzing the case after receiving only the most superficial information. Once more information is provided, students have the opportunity to incorporate more data into their analyses and refine their hypotheses. This type of activity mimics actual scientific research (Herreid, 2004). A potentially critical aspect of the directed case study, interrupted or not, is the in-class review. Students are required to share their answers with the rest of the class. Sharing predictions and conclusions with their peers allows students to reinforce concepts that are understood, while clarifying any misunderstandings that may have interfered with problem solving (Cliff & Curtin, 2001).

Davis & Elkins College (D&E) is a small, private liberal arts college that emphasizes small class sizes and strong faculty-student interactions. The Department of Biology and Environmental Science at D&E offers multiple specialization tracks for biology majors, including general biology, pre-medical, pre-veterinary, and secondary education. By far, the most popular track is pre-medical, and the department has been very successful in recent years at getting students accepted to medical schools. To prepare our students for the rigors of a medical education, we attempt to expose them to as much clinically relevant content as possible at the undergraduate level. Clinical case studies are utilized extensively in several courses that are available to pre-medical biology majors. The cases tend to be both directed

and closed-ended. In some courses, the interrupted case method is employed. Three courses, in particular, rely heavily on clinical case studies: Human Physiology, Functional Histology, and Biochemistry. While none of the courses is required for the biology degree, all three are strongly recommended for our pre-medical students.

Human Physiology

The Human Physiology course is an overview of basic physiology, with particular emphasis on the human nervous system, cardiovascular system, and renal function. It is a 100-level course that also enrolls pre-nursing students and exercise science majors. Lecture sections are relatively large, generally between 60 and 70 students. Laboratory sections, however, are capped at 24 students. Ten clinical case analyses are integrated into the laboratory curriculum. Each lab activity begins with an in-class presentation of the case by the instructor. Introductory information includes the case history, results of a physical exam, and relevant test results. See Table 1 for an example. Following the introduction, students are presented with five questions to answer by the end of the lab period. Students generally work in groups of three or four, using their textbooks and lecture notes to address the questions. The patient introduced in Table 1 is suffering from Bell's palsy. Questions accompanying this case include the following: Which cranial nerve is affected by this disorder? Why is there paralysis only on the left side of her face? What is the potential role of inflammation in this disorder?

Functional Histology

Functional Histology is designed to demonstrate fundamental relationships between microscopic anatomy and physiological function. Students identify specific cells and tissue types, relate microscopic structure to cellular function, and diagnose pathologies on the basis of histological abnormalities. It is a 200-level course, usually enrolling 10-15 biology majors. The lecture and laboratory components of the course are integrated into a "seamless" curriculum, with no breaks in between, as described by Burrowes and Nazario (2008). The class meets twice a week for two hours and 40 minutes. The class begins with lecture material, moves on to relevant lab activities, then back to more lecture, followed by more lab activities. Students analyze five clinical cases over the course of the semester. In lieu of introductory information, students are presented with two histological images of a certain tissue, one normal and one pathological. See Figures 1 and 2 for examples. Students work in groups of two or three

History You are presented with a 45-year-old Caucasian female patient exhibiting muscular paralysis on the entire left side of her face. The symptoms began about a week ago and have progressively gotten worse. The patient is on no medications and does not use alcohol, tobacco, or illegal drugs. There is no indication of family history.
Physical Exam The patient is unable to close her left eye completely and cannot raise her left eyebrow. When smiling, the patient's lips do not curl upward on the left side. However, there is no evidence of sensory loss in the face.
Tests White blood cell count: slightly elevated Urinalysis: normal MRI of brain: normal

Table 1: Introductory information for a Human Physiology clinical case.

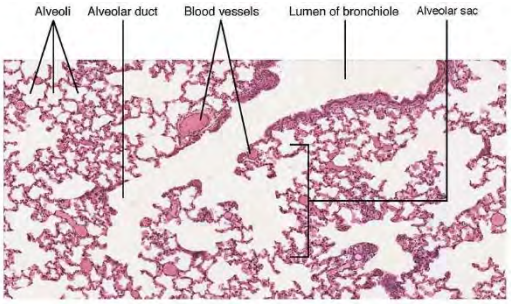

Fig. 1. Normal structures of the respiratory zone (Creative Commons).

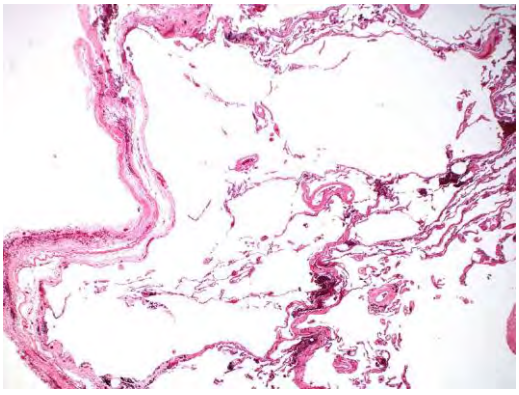

Fig. 2. Panlobular emphysema (Creative Commons).

to answer five questions that deal with the pathology, using only a histology atlas and their lecture notes. The pathology in Figure 2 is panlobular emphysema. Questions accompany this case include the following: What is abnormal about the patient's alveoli? How would this abnormality affect gas exchange? How would this abnormality affect quiet expiration?

Biochemistry

The Biochemistry course is a survey of major biological molecules and basic metabolic pathways. Topics include enzyme kinetics, metabolic regulation of glucose, and membrane transport. It is a 300-level course, generally enrolling 15-20 biology and chemistry majors. The course has no laboratory component, so clinical cases are analyzed during "lecture" time and outside of class as homework assignments. Five case analyses are integrated into the course. Each analysis begins with an in-class presentation of the case by the instructor. Introductory information includes the case history, results of a physical exam, and relevant test results. See Table 2 for an example. Classrooms are not modular, making it difficult to divide students into groups. Instead, three or four preliminary questions regarding the case are discussed as a class. Individual students provide input, and we talk through the analysis until we reach a consensus on answers to the preliminary questions. The patient introduced in Table 2 is suffering from Alzheimer's disease. Preliminary questions for this case include the following: What is your preliminary diagnosis? Who is at risk for this particular condition? What areas of the brain are affected? Once preliminary questions are sorted out, students are given a homework assignment. They are welcome to work individually or in pairs, using textbooks, lecture notes, and approved internet resources to complete the assignment, which is due at the beginning of the next class. All information obtained from online resources has to be cited appropriately, according to APA guidelines. For the case introduced in Table 2, the homework assignment consists of the following question and parenthetical disclaimer: How are ApoE, tau, and beta-amyloid proteins associated with Alzheimer's disease? (This is a 300-level biochemistry class. Don't be afraid to get into molecular interactions.) At the next class meeting, selected students share their findings with their peers. Since they may use different resources to complete the assignment, findings may vary. We compare and contrast the presented responses as a class and eventually reach a consensus on answers to the homework questions

Conclusion

Small-group learning has become extremely popular in medical schools in recent years (Burgess et al., 2014), and the clinical case report is one of the primary teaching tools utilized in medical education (Florek & Dellavalle, 2016). In an effort to prepare our pre-medical students for the active learning associated with current medical education, we provide multiple opportunities for them to experience clinical case teaching.

The case study method is extremely flexible. It can be utilized as a laboratory-based activity for small groups of students, as a discussion activity during lectures, and as a homework assignment for individuals or small groups. It is an efficient tool for promoting critical thinking, stimulating interest, and reinforcing course content.

History A 75-year-old Caucasian female is brought to your office by her daughter. While visiting for the holidays, the daughter noticed that her mother had lost a significant amount of weight in the past six months. Furthermore, she indicates that her mother has become increasingly irritable, fatigued, and forgetful.
Physical Exam The patient's heart rate is 74 bpm, and her blood pressure is 118/76. The patient is significantly underweight. She is 5 feet, 2 inches tall and weighs 96 pounds, giving her a BMI of 17.6. She is unable to identify her grandchildren and is unaware of the current date.
Tests Blood work indicates that the patient is anemic and dehydrated. A PET scan suggests possible amyloid plaque accumulation in the patient's brain.

Table 2. Introductory information for a Biochemistry clinical case.

References

BURGESS, A.W., MCGREGOR, D.M., AND MELLIS, C.M. 2014. Applying established guidelines to team-based learning programs in medical schools: A systematic review. Academic Medicine. 89(4): 678-688.

BURROWES, P. AND NAZARIO, G. 2008. Promoting student learning through the integration of lab and lecture. Journal of College Science Teaching. 37(4): 18-23.CLIFF, W.H. AND CURTIN, L.N. 2001. The directed case method: Teaching concept and process in a content-rich course. Journal of College Science. Teaching 30(1): 64-66.

CLIFF, W.H. AND NESBITT, L.M. 2005. An open or shut case? Contrasting approaches to case study design. Journal of College Science Teaching. 34(4): 14-17.

FLOREK, A.G. AND DELLAVALLE, R.P. 2016. Case reports in medical education: A platform for training medical students, residents, and fellows in scientific writing and critical thinking. Journal of Medical Case Reports. 10: 86.

FREEMAN, S., EDDY, S.L., MCDONOUGH, M., SMITH, M.K., OKOROAFOR, N., et al. 2014. Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Science. 111(23): 8410-8415.

GALLUCCI, K. 2006. Learning concepts with cases. Journal of College Science Teaching. 36(2): 16-20.

HERREID, C.F. 2004. Can case studies be used to teach critical thinking? Journal of College Science Teaching. 33(6): 12-14.

HERREID, C.F. 2009. The wisdom of groups. Journal of College Science Teaching. 39(2): 62-64.

SMITH, R.A. AND MURPHY, S.K. 1998. Using case studies to increase learning and interest in biology. American Biology Teacher. 60(4): 265-268