

## TEACHERS' TOPICS

### A Learner-led, Discussion-based Elective on Emerging Infectious Disease

Clinton Mathias, PhD

Western New England University College of Pharmacy, Springfield, Massachusetts

Submitted January 8, 2015; accepted May 5, 2015; published August 25, 2015.

**Objective.** To implement a learner-led, discussion-based course aimed at exposing second-year pharmacy learners to the study of emerging infectious diseases from a global health perspective and to assess the role and importance of pharmacists in the management of disease outbreaks.

**Design.** Learners examined literature pertinent to an emerging infectious disease in a 3-credit, discussion-based course and participated in peer discussion led by a designated learner. Instructional materials included journal articles, audio-visual presentations, documentaries, book chapters, movies, newspaper/magazine articles, and other materials. Learning outcomes were measured based on the ability of learners to perform critical thinking and analysis, communicate with their peers, and participate in class discussions.

**Assessment.** The course was offered to 2 consecutive cohorts consisting of 14 and 16 learners, respectively. Overall, every learner in the first cohort achieved a final grade of A for the course. In the second cohort, the overall grade distribution consisted of grades of A, B, and C for the course. Learner evaluations indicated that the active-learning, discussion-based environment significantly enhanced interest in the topic and overall performance in the course.

**Conclusion.** The elective course on emerging infectious diseases provided in-depth exposure to disease topics normally not encountered in the pharmacy curriculum. Learners found the material and format valuable, and the course enhanced their appreciation of infectious diseases, research methodology, critical thinking and analysis, and their roles as pharmacists.

**Keywords:** Learner-led, discussion, emerging infectious disease, elective course

## INTRODUCTION

Despite significant advances in public health measures and efforts to control the spread of infectious diseases, they continue to present a challenge to health and health care professionals throughout the world. In 2010, nearly a quarter of the estimated 52.8 million deaths worldwide were attributed to infectious diseases.<sup>1,2</sup> Moreover, in an era of globalized travel and trade, the rise of emergent and re-emergent infectious diseases in previously nonendemic areas is also becoming a reality.<sup>1</sup> The rise of antimicrobial resistance and the spread of superbugs in several parts of the world are further causes of concern and compound the problem of combating the spread of acute infectious diseases. Hence, a well-coordinated effort by teams of health care professionals, including pharmacists, is essential not only in curbing the

spread of infectious disease, but also in enacting public health measures and educating the public about specific diseases and the dangers of antimicrobial resistance.

Justo and colleagues' survey assessing the knowledge and attitudes of doctor of pharmacy (PharmD) learners regarding the appropriate use of antimicrobials demonstrated that, while pharmacy learners were concerned and aware of antimicrobial resistance, a higher knowledge score was associated with factors such as the pharmacy school or college attended, planned postgraduate training, and completion of a clinical practice experience in infectious diseases.<sup>3</sup> As a group, learners desired more education on the subject, and a suggestion was made that the sharing of best practices among institutions may enhance the preparation of future pharmacists to contribute to antimicrobial stewardship.<sup>3</sup> With the emergence of diseases such as Ebola in the United States, pharmacists may be called upon to play a greater role in educating the public and managing antimicrobial resistance issues and other public health challenges.<sup>4</sup>

This article describes the development of a discussion-based, emerging infectious disease elective course, the major goals of which were to expose second-year pharmacy

---

**Corresponding Author:** Clinton Mathias, Ph.D., Assistant Professor, Department of Pharmaceutical and Administrative Sciences, College of Pharmacy, Western New England University, 1215 Wilbraham Road, Springfield, MA 01119-2684. Tel: 413-796-2414; Fax: 413-796-2266; Email: clinton.mathias@wne.edu

learners to primary literature on emerging infectious diseases from a global health perspective and to examine the roles of pharmacists in the management of these diseases. Infectious diseases are emphasized in the academic curriculum at Western New England University College of Pharmacy, and the topic comprises 4 credits of the Integrated Pharmacy Care and Patient Management (IPC and PM) modules. However, the primary focus in these courses is on diseases and infections widely encountered by pharmacists in the United States, with limited exposure to emerging infectious diseases. The rationale behind the creation of this elective course was to not only introduce pharmacy learners to the study of emergent diseases, but also allow them to consider approaches to disease management from a public health context, with a specific emphasis on the roles of pharmacists as health care professionals. Furthermore, a discussion-based format focused on examination of the primary literature would make it a truly interactive course placing a significant onus on learners to deepen and enrich their own education.

## DESIGN

The 3-credit, discussion-based course was offered twice over 2 consecutive years and was comprised of 14 learners the first year and 16 learners the second year. The course description emphasized the discussion-based format with a focus on learning about emerging infectious diseases, as well as re-emergent infectious diseases thought to have been previously eliminated. The learner-centered approach of the course also was emphasized in the course description, noting particularly that learners would examine literature pertinent to select infectious diseases and discuss it with their peers. Table 1 lists the course learning outcomes and maps them to programmatic core competencies.

In the syllabus, pharmacy learners were reminded of their vital role as health care professionals in the advancing fields of medicine and health care. As one of the most frequently encountered community health care professionals, pharmacists have a major role to play in educating the public about disease states and the development of novel approaches to effective therapy. As such, well-rounded pharmacists must not only have knowledge about drugs used to treat diseases, but also be up to speed with recent advances in research and other novel measures aimed at curbing the spread of the disease. In addition, they also should be able to communicate this information appropriately to the target patient audience. Thus, while one of the goals of the course was for learners to learn about the emergence or re-emergence of infectious diseases, the major focus was on critically exploring recent

advances in research, including the latest breakthroughs in the field, and discussing roles pharmacists can play in educating the public and managing diseases.

Learners met for 3 hours per week, and a designated learner led a discussion on a topic and related clinical or research article. The discussion revolved around one or more of the following: the pathogenesis, diagnosis, epidemiology, prevention, and control of the disease, as well as roles pharmacists play as health care professionals in providing the public with adequate care and education. Diseases discussed include Ebola virus infection, multi-drug resistant-tuberculosis (MDR-TB), HIV/AIDS, methicillin-resistant *Staphylococcus aureus* (MRSA), severe acute respiratory syndrome (SARS), and avian and swine influenza. A complete list of disease topics, including the literature used for discussion and instructional materials, is provided in Table 2.

The classroom format was comprised of two components: discussion of research/clinical articles and oral presentations on selected diseases. The learner-led discussion of research papers was a pivotal part of the course. The instructor provided designated learners with a list of possible research articles, and learners also had the opportunity to search the literature on their own. In addition to research articles, the instructor provided reviews for background reading. The research articles and reviews were intended to complement each other and expand on the selected disease topics. All learners were expected to read articles and reviews in advance, whether leading the discussion or not. Other instructional materials included audio-visual presentations, documentaries, book chapters, movies, and newspaper/magazine articles. The instructor presented the first article to demonstrate the expected discussion format. All future article discussions were led by learners. During discussion, typically, the leader presented approximately 15 minutes of background on the topic and a brief summary of the research paper. Subsequently, the leader would discuss the hypothesis and experimental approach of the study, analyze the validity of the observations/experiments, critique the study, and propose new ideas and/or hypotheses. The goals of the discussion were for learners to not only understand the research presented in the paper, but also pick out its strengths and weaknesses, evaluate the importance of the research in the field, and consider future implications of the disease. All discussion leaders were encouraged to meet with the instructor for assistance in advance of the scheduled discussion and to prepare questions relevant to the article as a way of engaging classmates.

To stimulate discussion on some disease topics, learners were shown videos or movies and asked to assess the extent to which they were realistic and scientifically

Table 1. Course Learning Outcomes for the Emerging Infectious Disease Elective at the Western New England University College of Pharmacy (COP)

Learning Outcomes*	COP Core Competencies									
	Thinking and Learning	Social and Cultural Awareness	Citizenship and Leadership	Ethical and Legal Judgment	Communication	Knowledge Base	Patient-centered Care	Populations-based Care	Systems Management	Public Health and Wellness
Explain how select infectious diseases affect the world in a public health context.	X				X					X
Describe the biology of select infectious diseases with an emphasis on pathogenesis, epidemiology, and clinical symptoms.						X	X	X		X
Discuss strategies aimed at diagnosis, prevention, and control of select infectious diseases.	X				X		X	X		X
Discuss recent research/advances in medical science aimed at treatment and/or further understanding of select infectious diseases.	X				X		X	X		X
Propose scientific, cultural, religious, or governmental solutions with the eventual aim of curbing the spread of the disease.	X	X			X			X		X

\*After taking this course, the learner should be able to demonstrate the outcomes listed in the first column, in partial achievement of the COP core competencies to which they are mapped

Table 2. Topics and Instructional Materials Covered during the Emerging Infectious Disease Elective Course

Topic	Instructional Materials
Lyme Disease and Chronic Lyme Disease	Articles; <sup>12</sup> Reviews <sup>13-16</sup>
Ebola Virus Infection	Articles; <sup>17</sup> Reviews; <sup>18-21</sup> Movie: <i>Outbreak</i>
<i>Escherichia coli</i>	Article and Review <sup>22,23</sup>
Anthrax and Bioterrorism	Articles; <sup>5</sup> Reviews; <sup>6-9</sup> Documentary: <i>Anthrax, Smallpox and More: the Past and Lethal Future of Biological Warfare (PBS NOVA)</i>
West Nile Virus	Articles; <sup>24</sup> Reviews <sup>25,26</sup>
Malaria	Articles; <sup>10, 11</sup> Reviews <sup>27</sup>
MDR-TB	Articles; <sup>28-33</sup> Documentary: <i>The Evolutionary Arms Race Focusing on the Rise of MDR-TB (PBS NOVA)</i>
HIV-AIDS	Articles; <sup>34, 35</sup> Reviews <sup>36-40</sup>
MRSA	Articles <sup>41, 42</sup>
Prions/ Creutzfeldt-Jakob disease	Article; <sup>43</sup> Review <sup>44</sup>
Avian and Swine Influenza	Articles; <sup>45-48</sup> Movie: <i>Contagion</i>
Vaccines	Articles <sup>49, 50</sup>
SARS	Articles; <sup>51</sup> Reviews <sup>52,53</sup>
Book Discussion	Book: <i>The Andromeda Strain</i>

accurate and to discuss whether such scenarios were possible today. For example, the movie *Outbreak* was shown during the discussion of Ebola virus infection, and the movie *Contagion* was shown when discussing avian influenza. Watching the movies in concert with reading research articles stimulated intense discussion on these diseases. In addition to the movies, documentaries and videos were shown on other diseases such as anthrax, tuberculosis and HIV/AIDS. Finally, learners also were required to read and discuss the book, *The Andromeda Strain*, about a team of scientists called upon to investigate a deadly outbreak of a novel extraterrestrial organism.

## EVALUATION AND ASSESSMENT

Assessment during the course consisted of 5 separate components: research article discussion, research paper, oral presentations, peer evaluation, and final examination. Goals of the assessments were to provide learners an opportunity to enhance their knowledge on the current state of emerging infectious diseases and to help them think about ways they could share the knowledge they had gained with their peers and the public. The 14 learners in the first cohort performed well in all the assessment categories, all achieving a final grade of A in the course. In contrast, several learners in the second cohort (16 learners) struggled with the research article discussions. This was reflected in the overall grade distribution with 10 As, 5 Bs, and 1 C. No major changes were made during the second cohort, except that it was offered during spring semester, when learners also were taking their IPC and PM modules. A minor change during the second cohort was the selection of new research articles by learners.

Regarding the research article discussion, learners were assessed on preparation for the journal article discussion and their ability to lead the discussion (20% of grade). Specific criteria assessed included knowledge and comprehension of the topic, ability to critique journal articles and research studies, and the manner in which learners promoted class discussion. Out of 20 points, 5 were awarded for thorough preparation for the class discussion, 5 for knowledge displayed about the topic, 5 for critique of the research article, and 5 for engaging classmates in discussion. Although no specific prerequisites in biostatistics or literature evaluation were required for the course, all learners had taken 2 semesters of the Informatics course as part of the PharmD curriculum. While learners in the first cohort (14 learners) performed well overall in terms of having read the articles and leading class discussion (100% of designated learners received an A in this category on their chosen disease topic), several learners in the second cohort struggled with the class discussion. In this cohort of 16 learners, 56% received As, 6% received Bs, 13% received Cs, and 25% received Fs. The primary reasons identified for the second group's struggles, from the learners' perspective, were that they had either not read the article(s) thoroughly before the discussion, or they had a difficult time understanding the basic science concepts in the articles. More often, these learners were struggling to balance their time with the requirements for this elective course and the more stringent requirements of the rest of the curriculum (based on personal communication with learners). To facilitate discussion for learners who had not adequately prepared or who had difficulty comprehending the subject matter,

the instructor either asked learners in the group who had read the articles to contribute to the discussion or would lead parts of the discussion himself.

The second assessment component consisted of a short research paper that learners were required to write within 3 weeks of having led a research article discussion (20% of grade). After discussion of the research article, the leaders were required to gather several critiques and viewpoints regarding the study. Leaders were required to submit individual papers proposing a new hypothesis relevant to the discussion topic. Papers were required to include a brief overview of the question posed, pertinent background material, and an objective and study design describing how to test the hypothesis. Finally, the paper had to include an interpretation of potential outcomes including potential pitfalls of the proposed approach. For example, one hypothesis proposed by a learner was that a series of lectures on HIV/AIDS, which included the first-hand testimony of patients suffering from the disease, would be most effective in educating high school seniors of the dangers of the disease. Assessment criteria included the following: innovation (5 points), study design (5 points), study interpretation (5 points), and study pitfalls/alternative approaches (5 points). Most learners in both cohorts performed well on this assignment (12 As in the first cohort and 13 As in the second), and in their short papers, several offered novel approaches to studying a particular aspect of the disease pathogenesis, epidemiology, or treatment, based on the knowledge they gained from the research article discussions. However, most learners struggled with determining potential pitfalls of their proposed approach, suggesting they needed more practice assessing long-term consequences of their ideas.

The third assessment category was an oral presentation on an emerging infectious disease of the learners' choice (25% of the grade). The presentations were typically held during separate class sessions, unless a learner had chosen to do a presentation on their discussion topic, in which case they were allowed to present during their discussion session. Many learners reported the presentation was the easiest assignment, since typically, general information about the selected disease was easily available on the Internet. Some examples of presentation topics include Cholera, Hantavirus, Eastern Equine Encephalitis, Diphtheria, and Measles. For this assignment, learners had to prepare a PowerPoint presentation (5 points) and were assessed on their knowledge/grasp of the subject material (5 points), organization of slides (5 points), and effective delivery of the presentation (15 points). Learners in both cohorts performed well in this assessment category, with

100% receiving As in the first, and 50% each receiving As and Bs in the second cohort.

The fourth assessment category (5% of the grade) was a peer evaluation of classmates' oral presentations. As expected, while learners did provide critical feedback on presentations, in most cases they graded their peers highly. As such, all learners in both cohorts received As in this category.

The last category (30% of the grade) was an in-class final examination. The primary objective of the final examination was not to assess learners' knowledge about intricate details of topics discussed, but to assess whether learners had been able to acquire and develop critical-thinking skills in the course of their study of infectious diseases. Examples of examination questions included: "Write a letter to the president describing in detail how pharmacists can contribute to disease management and control were there to be a bioterror attack in the United States," or "Design a survey to assess the prevalence of antibiotic use and completion of antibiotic therapy in your community," or "You belong to a team of pharmacists that has been called upon in the wake of a novel Ebola crisis in your community. What contributions could you make to the team and what advice can you offer?" While the examination was a final opportunity to test learners on how well they had honed their critical-thinking skills, it was also meant to allow the learners to self-reflect on how well-prepared they saw themselves as health care professionals with expertise that may be necessary in the event of a disease outbreak. Learners performed well overall on the final examination with 13 receiving an A in the first cohort and 11 receiving an A in the second cohort.

In order to assess whether the elective, the instructional materials and formats, and the assessments fulfilled the objectives, course evaluations were conducted at the end of the course. The evaluations were completed online and were not mandatory. Ten and twelve responses were received from each cohort respectively, indicating a response rate of approximately 75%. The data from the evaluations are provided in Table 3. The study received institutional review board approval. The learner evaluations indicated that the learner-centered approach and discussion-based format significantly enhanced their learning experience and interest in the research topics and emerging infectious diseases. All learners who responded indicated the course was stimulating and intellectually challenging, the instructional materials increased their understanding, and the course helped them to develop stronger critical-thinking skills (Table 3). Comments from the course evaluations are given in Appendix 1.



Table 3. Summary of Course Evaluations for the Emerging Infectious Disease Elective during Academic Years 2012-2013 and 2013-2014

Learner Cohort, (No. responses)	Strongly Agree/Agree	
	Year 1, (10/14)	Year 2, (12/16)
The course objectives were well covered.	10/10	12/12
The course expectations were met.	10/10	12/12
The course challenged me intellectually.	10/10	12/12
The course concepts were presented in an organized manner.	10/10	11/12
Instructional material(s) increased my understanding.	10/10	11/12
The course assignments were interesting and stimulating.	10/10	12/12
The course helped me develop stronger critical-thinking skills.	10/10	12/12

## DISCUSSION

The 3-credit elective course was designed to introduce and expose pharmacy learners to the study of novel emerging infectious diseases normally not encountered within the pharmacy curriculum at the college. The second aim was to develop a course format that would give learners an opportunity to learn how to review and analyze the scientific literature, develop critical-thinking skills, design scientific studies, and effectively communicate their findings and perspectives with their peers, thus taking charge of their own scientific learning. Nationally, schools of pharmacy have placed an important emphasis on the development of courses that encourage critical thinking and literature analysis by learners.<sup>54-59</sup> The 2011-2012 Argus Commission, composed of the past five presidents of the American Association of Colleges of Pharmacy (AACCP), was specifically tasked with developing strategies to increase an attitude of inquisitiveness and scholarly thinking in pharmacists.<sup>60</sup> Similarly, the combined report of the 2005-2006 Argus Commission and various committees suggested that “problem-based learning and case discussion exercises are learning formats which stimulate problem-solving and critical thinking skill development.”<sup>61</sup> The Accreditation Council for Pharmacy Education (ACPE) Standards 2016 place an emphasis on development of electives that permit exploration of and/or advanced study in areas of professional interest (Standards 10.9 and 10.12).<sup>62</sup> Moreover, the standards emphasize both the incorporation of the study of infectious diseases with a focus on microbiology, pathophysiology, immunology, and therapeutics, as well as the management of diseases from a public health perspective.<sup>62</sup>

The design of the course helped raise learners’ awareness levels regarding infectious diseases. Many learners had never heard of some of the diseases covered in the course. Several learners mentioned in class that they were shocked to learn about the extent of MDR-TB in various parts of the world or read about the ease of using

anthrax as a bioterrorism agent in the United States. One particular learner became so concerned about extensively drug-resistant TB that she not only gave a comprehensive oral presentation on the state of the crisis, but also took steps to interact with her peers to educate them about the problems of antibiotic resistance. When episodes of Ebola hit the United States this year, several learners told the instructor how relevant and important the elective had been for them. One learner made specific mention of this to the entire classroom during the infectious disease module in the IPC and PM curriculum (of which the instructor is a co-instructor). Thus, learners appeared to have benefited from learning about emerging and re-emerging infectious diseases.

The second aim challenged learners in several areas. The review and critique of published study results (especially in the basic sciences) was intellectually stimulating but also challenging for several learners. An example of how the research article is to be critiqued and discussed was provided in the first lecture. While learners in the first cohort adapted well to these skills, some learners in the second cohort struggled. A primary reason given by these learners was that they were having a difficult time reading the research articles and balancing the requirements of this course with IPC and PM requirements. Thus, in future years, it may be beneficial to offer the course to learners who are not also taking their IPC and PM courses. However, offering the course during the spring semester not only challenged the learners intellectually, but several learners also said in their evaluations that it helped with their IPC and PM courses.

For learners who struggle to find time for research articles or understand concepts, it may be helpful to provide an assignment that compels learners to read articles and prepare for their discussion by a specific deadline. For example, learners could be asked to come up with discussion questions about the article beforehand and submit them to the instructor the day prior to their discussion. This approach has been successfully used by the

instructor in other courses where research articles are discussed.

The discussion of research articles was a highlight of this course. Several learners enjoyed this format, as noted in the course evaluations. At times, learners intensely debated the merits of a particular approach and study, or the pros and cons of aspects of the studies, suggesting they benefited from engaging with each other on the topics and questioning the study designs and methods.

Many learners had difficulties coming up with potential pitfalls in their study designs. Although identifying pitfalls in studies was done on a regular basis while discussing research articles, several learners had not yet been able to critique their own ideas and thought processes. Thus, it may be helpful to demonstrate this process in a lecture format instead of discussion format.

Many learners said the final examination was helpful in putting the course into perspective. One learner designed an extensive survey on antibiotic resistance as part of his answer to a final examination question. He enjoyed the course so much that he asked the instructor whether he could participate in a research project and eventually worked with the instructor on a study assessing the perceptions of pharmacists about antibiotic resistance. Many of the questions included in the study were adapted from those the learner designed during the examination.

The 5 assessment categories were developed to achieve learning outcomes described in Table 1. While learning outcomes 2, 3, and 4 were routinely achieved during the research article discussion sessions, learners were constantly reminded throughout the course to incorporate learning outcomes 1 and 5 in the 4 major assessment categories. For example, learning outcome 5 states learners should be able to propose scientific, cultural, religious, or governmental solutions with the eventual aim of curbing the spread of the disease. This outcome was assessed in the 4 major assessment categories (except peer evaluation). During research article discussions, learners routinely discussed alternative approaches to the study. Similarly, the research paper was specifically geared toward assessing this objective, requiring learners to propose a novel hypothesis or study design pursuant to the research article discussions. While this often included the testing of a novel drug target, learners also proposed studies that would assess the impact or consequences of cultural, religious, or governmental innovations in treatment and management of the disease. For example, in one of the research papers submitted on Ebola virus infection, a learner proposed working with the governments of nations in the sub-Saharan region to break down political barriers for funding, educating the public about proper hygiene, especially with respect to taking care of the

deceased, dispelling religious superstitions and myths about the infection, and allaying fears about “white scientists covered in gowns and masks.” Similarly, outcomes 1 and 5 also were emphasized during the oral presentations. For example, a learner showed a video on how proper hygiene is critical in controlling the spread of cholera in the underdeveloped world and how pharmacists in endemic regions can play a role in educating the public. Lastly, learners were assessed on outcome 5 during the final examination. For example, learners were required to design a study surveying the use of antibiotics in the community or to propose novel measures that could be taken during a bioterrorism attack.

In a similar fashion, outcome 1 (learners should be able to explain how select infectious diseases affect the world in a public health context) was assessed in all 4 major assessment categories. For example, one of the research articles discussed included “Public Response to an Anthrax Attack: Reactions to Mass Prophylaxis in a Scenario Involving Inhalation Anthrax from an Unidentified Source” by Steelfisher *et al.*<sup>17</sup> In order to prepare learners for the discussion of this article, reviews on anthrax were provided, a documentary on bioterrorism was shown, and two articles describing the anthrax terror attacks in Sverdlovsk in 1979 and Tokyo in 1993 were handed out.<sup>18,20,21</sup> The Steelfisher article described a survey of the American public conducted after the September 11 terrorist attacks regarding their response to a mass prophylaxis program were there to be a bioterror attack in the United States. Their findings indicated that “public health officials may face several challenges to compliance, including misinformation about the contagiousness of inhalation anthrax; fears about personal safety in crowds; distrust of government agencies to provide sufficient, safe, and effective medicine; and hesitation about ingesting antibiotic pills after receiving them.” During the discussion of the article, a specific emphasis was placed on what roles pharmacists could play to alleviate the concerns of the public and how they could assist public health officials in meeting these challenges. For example, one suggestion offered by learners was that pharmacists could provide handouts in their communities regarding “facts about inhalation anthrax” and the “efficacy of antibiotics.” Other suggestions included: pharmacist-conducted clinics where the community would be provided with antibiotics, pharmacist participation in public health response teams, and a panel of health care professionals that would provide seminars to the public.

Another example of a disease discussed in view of a global health perspective was malaria. Two articles discussed were “Malaria Resurgence: a Systematic Review and Assessment of its Causes,” by Cohen *et al.*, and “The

Public Health Impact of Chloroquine Resistance in Africa” by Trape.<sup>25,26</sup> The discussion primarily centered on the weakening of malaria control programs in African nations from lack of funding, war, poverty, compliance issues, and other socioeconomic considerations. Similarly, the effects of chloroquine resistance on mortality and, consequently, on the general health and economy of the public, also were discussed. Other examples included a learner-led discussion of the changing epidemiology of HIV/AIDS in the United States and the development of novel testing strategies,<sup>34</sup> and an oral presentation by another learner on educational strategies aimed at removing the stigma associated with being HIV-positive.

Learner evaluations indicated that the elective course fulfilled the aims of exposing learners to the study of emerging infectious diseases and provided learners an opportunity to develop analytical and research methodology skills. The classroom discussion format in particular, with its emphasis on a “learner-centered” approach, allowed learners to take charge of their own intellectual growth and enhanced their appreciation for the scientific method and analysis. Learners in both cohorts had not yet taken the IPC and PM infectious disease modules and, therefore, had no prior instruction concerning infectious diseases or treatment other than what was presented in their introductory immunology course in the first professional year of the program. The elective course could be offered later in the curriculum, after learners have completed those modules. Such a move would provide learners with more background in treatment of infectious diseases and perhaps help them more critically analyze the manuscripts and studies they discuss and present in the course.

## SUMMARY

With the advent of once novel infectious diseases in the United States, such as Ebola, SARS, and enterovirus D68, as well as the re-emergence of diseases thought to be controlled such as MDR-TB, there is a greater need for interprofessional teams to educate the public and combat these diseases.<sup>4,63</sup> Pharmacists have a vital role to play in this scenario because they are one of the most frequently encountered health care professionals in the community. This elective course offered PharmD learners the opportunity to learn about several emerging infectious diseases, to critically review the literature related to such diseases, and to engage in intense discussion with peers. Course evaluations indicated learners enjoyed the course and benefited from it in terms of enhancing their education. Thus, the course could be a potential template to enhance education among pharmacy learners regarding other

health care topics. In fact, the format is now used in an Immunology course and the Infectious Disease modules.

## ACKNOWLEDGMENTS

The author would like to thank Drs. Evan Robinson, James Knittel, Michael Thomas, and Matthew Dintzner for discussion and comments.

## REFERENCES

1. Khabbaz RF, Moseley RR, Steiner RJ, Levitt AM, Bell BP. Challenges of infectious diseases in the USA. *Lancet*. 2014;384(9937):53-63.
2. Morens DM, Fauci AS. Emerging infectious diseases: threats to human health and global stability. *PLoS pathogens*. 2013;9(7):e1003467.
3. Justo JA, Gauthier TP, Scheetz MH, et al. Knowledge and attitudes of doctor of pharmacy students regarding the appropriate use of antimicrobials. *Clin Infect Dis*: 2014;59 (Suppl 3):S162-169.
4. Guarascio AJ, Faust AC, Sheperd L, O'Donnell LA. Ebola Virus Disease: Roles and Considerations for Pharmacists. *Ann Pharmacother*. 2015;49(2):247-249.
5. Johnson M, Feder HM, Jr. Chronic Lyme disease: a survey of Connecticut primary care physicians. *J Pediatr*. 2010;157(6):1025-9 e1-2.
6. Steere AC, Coburn J, Glickstein L. The emergence of Lyme disease. *J Clin Invest*. 2004;113(8):1093-1101.
7. Steere AC, Glickstein L. Elucidation of Lyme arthritis. *Nat Rev Immunol*. 2004;4(2):143-152.
8. Lantos PM. Chronic Lyme disease: the controversies and the science. *Expert Rev Anti Infect Ther*. 2011;9(7):787-797.
9. Cameron DJ. Insufficient evidence to deny antibiotic treatment to chronic Lyme disease patients. *Med Hypotheses*. 2009;72(6):688-691.
10. Bausch DG, Sprecher AG, Jeffs B, Boumandouki P. Treatment of Marburg and Ebola hemorrhagic fevers: a strategy for testing new drugs and vaccines under outbreak conditions. *Antiviral Res*. 2008;78(1):150-161.
11. Ansari AA. Clinical features and pathobiology of Ebolavirus infection. *J Autoimmun*. 2014;55:1-9.
12. Feldmann H, Jones S, Klenk HD, Schnittler HJ. Ebola virus: from discovery to vaccine. *Nat Rev Immunol*. 2003;3(8):677-685.
13. Vogel G. Conservation biology. Can great apes be saved from Ebola? *Science*. 2003;300(5626):1645.
14. Vogel G. Epidemiology. Ebola outbreaks may have had independent sources. *Science*. 2004;303(5656):298-299.
15. Donnenberg MS, Finlay BB. Combating enteropathogenic Escherichia coli (EPEC) infections: the way forward. *Trends Microbiol*. 2013;21(7):317-319.
16. Vincent C, Boerlin P, Daignault D, et al. Food reservoir for Escherichia coli causing urinary tract infections. *Emerg Infect Dis*. 2010;16(1):88-95.
17. SteelFisher G, Blendon R, Ross LJ, et al. Public response to an anthrax attack: reactions to mass prophylaxis in a scenario involving inhalation anthrax from an unidentified source. *Biosecur Bioterror*. 2011;9(3):239-250.
18. Franz DR. Preparedness for an anthrax attack. *Mol Aspects Med*. 2009;30(6):503-510.
19. Meselson M, Guillemin J, Hugh-Jones M, et al. The Sverdlovsk anthrax outbreak of 1979. *Science*. 1994;266(5188):1202-1208.



20. Takahashi H, Keim P, Kaufmann AF, et al. Bacillus anthracis incident, Kameido, Tokyo, 1993. *Emerg Infect Dis.* 2004;10(1):117-120.
21. Riedel S. Anthrax: a continuing concern in the era of bioterrorism. *Proc (Bayl Univ Med Cent.* 2005;18(3):234-243.
22. Diamond MS, Sitati EM, Friend LD, Higgs S, Shrestha B, Engle M. A critical role for induced IgM in the protection against West Nile virus infection. *J Exp Med.* 2003;198(12):1853-1862.
23. Campbell GL, Marfin AA, Lanciotti RS, Gubler DJ. West Nile virus. *Lancet Infect Dis.* 2002;2(9):519-529.
24. Weise E. West Nile virus spreads faster. *USA Today.* August 14, 2012, 2012.
25. Cohen JM, Smith DL, Cotter C, et al. Malaria resurgence: a systematic review and assessment of its causes. *Malar J.* 2012;11:122.
26. Trape JF. The public health impact of chloroquine resistance in Africa. *Am J Trop Med Hyg.* 2001;64(1-2 Suppl):12-17.
27. Miller LH, Baruch DI, Marsh K, Doumbo OK. The pathogenic basis of malaria. *Nature.* 2002;415(6872):673-679.
28. Kline SE, Hedemark LL, Davies SF. Outbreak of tuberculosis among regular patrons of a neighborhood bar. *N Engl J Med.* 1995;333(4):222-227.
29. Ben Amor Y, Nemser B, Singh A, Sankin A, Schluger N. Underreported threat of multidrug-resistant tuberculosis in Africa. *Emerg Infect Dis.* 2008;14(9):1345-1352.
30. Anand G. Q&A: the threat of drug-resistant tuberculosis. *Wall Street Journal.* June 20, 2012.
31. Sansom C. The latent threat of tuberculosis. *Chemistryworld;* 2012.
32. Iyer M. New form of TB gives doctors sleepless nights. *The Times of India.* March 24, 2012.
33. Rowland K. Totally drug-resistant TB emerges in India. *Nature;* January 13, 2012.
34. Fenton KA. Changing epidemiology of HIV/AIDS in the United States: implications for enhancing and promoting HIV testing strategies. *Clin Infect Dis.* 2007;45(Suppl 4):S213-220.
35. Gu L, Tsuji T, Jarboui MA, et al. Intermolecular masking of the HIV-1 Rev NLS by the cellular protein HIC: novel insights into the regulation of Rev nuclear import. *Retrovirology.* 2011;8:17.
36. Hladik F, McElrath MJ. Setting the stage: host invasion by HIV. *Nat Rev Immunol.* 2008;8(6):447-457.
37. Robinson HL. Working towards an HIV/AIDS vaccine. *Human Vac.* 2009;5(7):436-438.
38. Robinson HL. Opinion: Progress toward an HIV/AIDS vaccine. *TheScientist;* May 11, 2011.
39. Walker BD, Yu XG. Unravelling the mechanisms of durable control of HIV-1. *Nat Rev Immunol.* 2013;13(7):487-498.
40. Waters H. Vaccine primes T-cells for SIV. *TheScientist;* May 11, 2011.
41. Pastagia M, Kleinman LC, Lacerda de la Cruz EG, Jenkins SG. Predicting risk for death from MRSA bacteremia. *Emerg Infect Dis.* 2012;18(7):1072-1080.
42. Rynda-Appl A, Dobrinen E, McAlpine M, et al. Virus-like particle-induced protection against MRSA pneumonia is dependent on IL-13 and enhancement of phagocyte function. *Am J Pathol.* 2012;181(1):196-210.
43. Prince LA, Mann D, Reilly T. Creutzfeldt-Jakob disease: an emergency department presentation of a rare disease. *J Emerg Med.* 2006;31(1):41-44.
44. Knight RS, Will RG. Prion diseases. *J Neurol Neurosurg Psych.* 2004;75(Suppl 1):i36-i42.
45. Li KS, Guan Y, Wang J, et al. Genesis of a highly pathogenic and potentially pandemic H5N1 influenza virus in eastern Asia. *Nature.* 2004;430(6996):209-213.
46. Palese P. Influenza: old and new threats. *Nat Med.* 2004;10(12 Suppl):S82-S87.
47. Ghose T. Blocking flu death. *TheScientist;* September 15, 2011.
48. Ghose T. 1918 Flu Spread Before Peak. *TheScientist;* September 19, 2011.
49. Alcindor Y. Anti-vaccine movement is giving diseases a 2nd life. *USA Today.* Apr 8, 2014.
50. Slifka MK, Amanna I. How advances in immunology provide insight into improving vaccine efficacy. *Vaccine.* 2014;32(25):2948-2957.
51. Ksiazek TG, Erdman D, Goldsmith CS, et al. A novel coronavirus associated with severe acute respiratory syndrome. *N Engl J Med.* 2003;348(20):1953-1966.
52. Pearson H, Clarke T, Abbott A, Knight J, Cyranoski D. SARS: what have we learned? *Nature.* 2003;424(6945):121-126.
53. Peiris JS, Guan Y, Yuen KY. Severe acute respiratory syndrome. *Nat Med.* 2004;10(12 Suppl):S88-S97.
54. Cisneros RM. Assessment of critical thinking in pharmacy students. *Am J Pharm Educ.* 2009;73(4):Article 66.
55. Dawn S, Dominguez KD, Troutman WG, Bond R, Cone C. Instructional scaffolding to improve students' skills in evaluating clinical literature. *Am J Pharm Educ.* 2011;75(4): Article 62.
56. Miller D. An assessment of critical thinking: can pharmacy students evaluate clinical studies like experts? *Am J Pharm Educ.* 2004;68(1):Article 5.
57. Overholser BR, Foster DR, Henry JR, Plake KS, Sowinski KM. The influence of an elective introductory clinical research course on pharmacy student interest in pursuing research-based careers. *Am J Pharm Educ.* 2010;74(9):Article 165.
58. Oyler DR, Romanelli F. The fact of ignorance: revisiting the Socratic method as a tool for teaching critical thinking. *Am J Pharm Educ.* 2014;78(7):Article 144.
59. Thomas MC, Macias-Moriarty LZ. Student knowledge and confidence in an elective clinical toxicology course using active-learning techniques. *Am J Pharm Educ.* 2014;78(5): Article 95.
60. Speedie MK, Baldwin JN, Carter RA, Raehl CL, Yanchick VA, Maine LL. Cultivating 'habits of mind' in the scholarly pharmacy clinician: report of the 2011-12 Argus Commission. *Am J Pharm Educ.* 2012;76(6):Article S3.
61. Roche VF, Nahata MC, Wells BG, et al. Roadmap to 2015: preparing competent pharmacists and pharmacy faculty for the future. *Am J Pharm Educ.* 2006;70(Suppl):Article S5.
62. Accreditation Council for Pharmacy Education. Accreditation standards and key elements for the professional program in pharmacy leading to the doctor of pharmacy degree. <https://www.acpe-accredit.org/pdf/Standards2016FINAL.pdf>. Accessed on August 12, 2015.
63. Ernst EJ, Klepser ME, Bosso JA, et al. Recommendations for training and certification for pharmacists practicing, mentoring, and educating in infectious diseases pharmacotherapy. *Pharmacotherapy.* 2009;29(4):482-488.

*American Journal of Pharmaceutical Education 2015; 79 (6) Article 81.*

Appendix 1. Specific Comments from Course Evaluations on the Emerging Infectious Disease Elective Offered at the Western New England University College of Pharmacy

Year 1	Year 2
Great elective. Very stimulating. Discussions were awesome and made everyone try to think out of the box, and from different points of view.	Best class I've taken at WNE.
Interesting and informative course, enjoyed the discussion based format.	This was a good course, it was one of the courses that helped me learn and think more than other courses have.
Overall this course was the best elective choice! It was mainly student run (ie, we made presentations and led discussions) which helped us learn from each other and to have to teach one another. It was a great way to set up the elective!	Helped bring together previous course material together.
Going through the articles on the various infectious diseases helped understand the learning of each disease.	A fun and intellectually challenging course that really helps give perspective on emerging infectious disease and public health.
The course was a great elective that gave me better insight into several emerging infectious diseases that exist across the world. It gave me a better understanding of how these diseases should be approached in the areas of prevention, treatment, etc. The discussion approach of the class made it a very relaxing course that I looked forward to attending every week.	I see this class as more of a think tank. It allowed room for intellectual growth and discussion.
This is definitely a class that the more you put into the class the more you get out of the class. I genuinely enjoyed preparing for class and the discussions that we had in class.	Great course to be offered, and should be a choice for the incoming years. Course provides a window in to emerging diseases that are/would not be discussed in other courses. The course itself also provided more practice in reading journal articles and case studies, which is very helpful and useful!
Very interesting topics. I really enjoyed the small class size with interactive discussions.	Really liked how he let us choose our own articles and presentations. I loved the class, it was certainly the best I've taken so far at WNE. I learned a lot about topics of importance! A+ Great guidance, given that the most of class is student run. A little more clarity in the write up would be great. As for peer evaluations, it would be great to allow students to read the feedback to help improve presentations in the future. I thoroughly enjoyed partaking in this class. I learned a lot of ID and I'm sure everyone will enjoy taking this elective. LOVED this class and its open format. Learned a lot and had fun.