Integrating Emerging Infections Education into Medical Education:
An Innovative Approach

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Abstract

Introduction: All graduating physicians should be competent with the basic principles of contagious disease outbreak detection and management. In order to educate our students and residents on this important topic, we created a three-hour workshop that included a case-based simulation exercise, and we offered a two-week medical student course in Emerging Infections and Bioterrorism.

Methods: Twenty-two emergency medicine residents and sixty-four senior medical students rotating in the emergency department of an urban university tertiary referral center participated in a three-hour workshop between July 2005 and April 2006. Pre- and post-workshop surveys given immediately before and immediately following each session were used to determine participant satisfaction and self-reported knowledge and confidence in outbreak response. In March 2006 we offered a medical student elective course in Emerging Infections and Bioterrorism. Thirteen fourth-year medical students from a variety of specialties attended the two-week course. The course focused on selected topics in emerging and re-emerging infections and addressed general principles of infection control and biological disaster planning for healthcare facilities. A survey was given to all graduating fourth-year medical students in 2005 and 2006, before and after creation of the didactic course, to evaluate their comfort and perceived knowledge of outbreak detection and containment.

Results: Overall, both students who participated in the workshop and those who participated in the didactic course (with or without the workshop) showed improvement in self-reported knowledge of outbreak detection and management, although the effect was statistically significant only for those participating in the didactic course. Due to the small numbers of emergency medicine residents who completed the surveys, we cannot comment on the effectiveness of the resident workshop, although there was a trend toward improved self-reported knowledge after the workshop. Students pursuing internal medicine, pediatrics, emergency medicine, and ENT were most likely to report that outbreak education was very important. Nearly all participants felt outbreak preparedness was not covered in existing curricula, and 92% thought the workshop was beneficial.

Conclusions: Most participants felt that outbreak preparedness was not adequately addressed in their curricula and almost all wanted more instruction. In addition, the didactic course and workshop improved self-reported student knowledge of the basic principles of contagious disease outbreak detection and management. Based on the results of our study, we propose integration of a three-hour simulation-based workshop with other instructional endeavors in emerging infections and biopreparedness into medical education curricula. We recommend the offering of a more comprehensive course for those pursuing emergency medicine and the primary care specialties, as they will be the most likely to encounter an outbreak. A web-based course may be a desirable alternative for institutions that could not otherwise add this training to their curriculum due to logistical reasons or time constraints. Further research is needed to determine the feasibility and effectiveness of these educational strategies.
Diagnosis and therapy of illnesses caused by emerging infectious diseases and biological weapons are important skills that all physicians should possess. Despite this, a 2001 survey by the American Association of Medical Colleges (AAMC) indicated that only 1 of 125 medical schools offered training in biological or chemical preparedness. In response, the AAMC put forth guidelines for teaching bioterrorism preparedness in undergraduate medical curricula. The AAMC guidelines stated training should include recognition of specific biological and chemical agents as well as emerging diseases leading to a public health threat, treatment of victims of bioterrorism or contagious disease outbreaks, increased awareness of epidemiologic principles, and the role of law enforcement. By 2003, only 63 schools (approximately 50%) included biological and chemical preparedness in their curriculum, and to date many schools have yet to adopt the AAMC guidelines.1,2

The 22 cases of bioterrorism-associated anthrax following the attacks on the World Trade Center in September 2001 heightened public awareness of the potential hazard of infectious disease outbreaks and increased healthcare provider interest in this topic. The 2003 worldwide SARS epidemic with over 8000 cases and nearly 800 estimated deaths and the recent emergence and spread of Avian Influenza H5N1 among wild birds and poultry stocks have led public health officials to focus beyond bioterrorism and toward emerging infections preparedness in general. Although many emerging diseases, such as the viral hemorrhagic fevers, avian influenza, malaria, plague and cholera, affect the developing world disproportionately, the threat of infectious disease from global travel is substantial. More than 1 billion passengers travel worldwide by air annually, with the potential for aerosol transmission of infectious agents on airplanes. Approximately 1-5% of these travelers will become ill from their travels.1,3,4

All medical personnel can benefit from some level of biological preparedness training. A sample of United States Emergency Medical Services (EMS) providers surveyed regarding training in weapons of mass destruction, biological/chemical/radiological terrorism and public health emergencies showed that local and state departments of health provided little training. Yet those who had received training were found to have a significant improvement in comfort in responding to an event after training.5 While the need for training is evident, significant shortfalls in training exist. A cross-sectional, specialty-stratified random sample of 1200 licensed physicians providing a 46 item questionnaire regarding bioterrorism and public health emergency preparedness knowledge found that 71% felt training was essential; yet only 44% had received training in the past year.6

Hospital Emergency Departments and ambulatory clinics may be the first to recognize a contagious disease outbreak or bioterrorism-associated event. A survey of over 600 primary care physicians in 2002 found that although only 18% had had prior training on bioterrorism recognition and treatment, 93% thought it was needed.7 Emergency physicians were more likely than primary care physicians to have had bioterrorism preparedness training in the past year. Nonetheless, on a knowledge based questionnaire, there was no statistically significant difference in the number of questions correctly answered for the two groups.6 By 2005, 1150 surveys for 33 hospitals of Emergency Department staff providing patient care revealed that 93% felt that it was important to be trained.8

Because Emergency Medicine and Primary Care physicians are the most likely to encounter the sentinel case for a contagious disease outbreak, most medical schools and residency programs have focused on training during those rotations. The Emergency Medicine rotation is an optimal environment for medical students to learn acute management of many infectious disease processes, as well as the importance of infection control, given its focus on appropriate admission and discharge of patients. At our institution, Emergency Medicine is a mandatory four-week clerkship. At this point in their undergraduate medical career, medical students have had training in the basic sciences, as well as rotations in outpatient and inpatient medicine. Providing training in outbreak preparedness in the fourth year clerkship reinforces basic science principles while providing a context for detection and management of sentinel cases.

Despite the potential for widespread morbidity of a contagious disease outbreak,such as influenza, most medical education curricula under emphasize epidemiology and contagious disease outbreak preparedness. We created a case-based workshop and two-week medical student elective in emerging infectious diseases and bioterrorism to address the perceived deficiencies in our curriculum.

Objectives

The first objective was to determine if an educational workshop would improve clinicians’-in-training comfort level with infectious disease outbreak management and to increase awareness of resources. The second objective was to determine if students who participate in a two-week didactic course in emerging infectious diseases and bioterrorism have improved comfort levels in responding
Study Methods

The study was approved by the Institutional Review Board of the George Washington University. A survey was given to all graduating fourth-year medical students on self-reported knowledge and comfort with outbreak management prior to implementing our workshop and didactic course. The survey was distributed in March 2005 during the Practice of Medicine culminating course, an intensive two-week experience designed to refine clinical skills and knowledge needed during residency training. These medical students served as the control group for our educational study.

Twenty-two emergency medicine residents and sixty-four senior medical students rotating in the emergency department of an urban university tertiary referral center participated in our three-hour workshop between July 2005 and April 2006. Pre- and post- workshop surveys given immediately before and immediately following each workshop were used to determine participant satisfaction and self-reported knowledge and confidence in outbreak response.

Beginning in July 2005, the contagious disease outbreak workshop was held approximately monthly during the mandatory four-week emergency medicine clerkship for fourth year medical students. The same survey given to the control group of 2005 medical students was given to the 2006 graduating medical students during their Practice of Medicine culminating course. Seventy eight students completed the survey in 2005 and seventy nine completed it in 2006. The Chi square and Fisher exact tests were used for statistical analysis of results.

Results

At our institution, fourth year medical students are required to complete either a four-week research elective or a two-week didactic elective. In March 2006 we offered a four year elective course in Emerging Infections and Bioterrorism. Thirteen fourth-year medical students from a variety of specialties attended the didactic course. The course focused on selected topics in emerging and re-emerging infections and addressed general principles of infection control and biological disaster planning for health care facilities.

Table 1: Description of Contagious Disease Outbreak Workshop

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|-----------------------------------------------------|
| The workshop, conducted for medical students during their emergency medicine clerkship and for our emergency medicine residents, incorporates the core competencies of systems-based practice, practice-based learning, and patient care. The workshop is held in a hospital conference room, with the availability of internet, telephone, and other hospital resources, simulating “real life”. A hypothetical case of Ebola in a returned traveler presenting to an emergency department is outlined. Participants are then divided into small groups of two or three students, each group representing the Emergency Department physician, the local health department, the Centers for Disease Control (CDC), Hospital Administration, the Hospital Epidemiologist, and the Laboratory Director. The groups have 30 minutes to define their roles and responsibilities in preparation for the hypothetical outbreak, using telephone, internet and other hospital resources such as the laboratory and Infection Control nurse. A companion manuscript is provided. Each group presents and explains their approach to and responsibilities in responding to the outbreak. The faculty facilitator then gives a 60-minute case-based lecture covering the topics of syndromic surveillance, outbreak reporting, public health reporting mechanisms, laboratory safety, general epidemiologic principles and patterns for an outbreak, infection control measures, and a discussion of available resources. |

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Results

Twenty-two Emergency Medicine Residents and sixty-four senior medical students completed the contagious disease outbreak workshop surveys. Statistical analysis was performed using Epi Info™ software using the Chi square and Fisher exact tests. Overall, both students who participated in the workshop and those who participated in the didactic course (with or without the workshop) showed improvement in self-reported knowledge of outbreak detection and management, although the effect was statistically significant only for those participating in the didactic course. The greatest improvement in comfort was in accessing resources. Due to the small numbers of emergency medicine residents who completed the surveys, we cannot comment on the effectiveness of the resident workshop, although there was a trend toward improved self-reported knowledge after the workshop.

There was a statistically significant likelihood of students reporting they would initially consult Infectious Disease in the event of an outbreak, as opposed to hospital administration or local or national public health...
authorities (p-value 0.014, Fisher exact test), for those having taken the two-week Emerging Infections course as compared to the three-hour workshop alone.

Ninety-two percent of the students and residents felt that the workshop was beneficial. The overall quality ratings for the workshop were 93% giving marks of 4/5 or better on a 5 point scale. The interactive component of the workshop was well received, with many students commenting on the effectiveness of this approach.

Students pursuing the fields of internal medicine, pediatrics, emergency medicine, and ENT were most likely to report that outbreak detection and containment were “Indispensable” or “Very Important” to their field. Likewise, these participants were more likely to respond that contagious disease outbreak education is important to medical education. Nearly all survey participants responded that outbreak preparedness is not covered elsewhere in existing curricula.

Discussion

Teaching Contagious Disease Outbreak Education to Medical Students - Important questions medical educators addressing this topic need to ask are the following:

1. What essential topics should be covered in a curriculum on emerging infectious diseases?

   General principles should be covered that will allow students to feel comfortable in accessing resources in the event of an outbreak, apply general infection control and containment measures, be familiar with basic epidemiologic principles, and develop attitudes that will enable future partnerships with public health and subspecialty colleagues in the event of an outbreak. Common specific agents and diseases should be taught, with a greater emphasis on infectious diseases rather than bioterrorism.

2. What is the best timing to produce physicians who are prepared regarding a basic understanding of contagious disease outbreak detection and containment?

   The Microbiology course in the pre-clinical years of the medical school curriculum provides fundamental principles for infectious disease epidemiology and basic science. These concepts must be emphasized and re-introduced during the clinical years when students will have had enough exposure to conceptualize the principles of outbreak preparedness.

3. What recommendations can be made on what can be achieved with a workshop as compared with a longer course? What should be reasonable expectations from each component?

   A three-hour workshop may not be sufficient for medical students to be skilled with the principles of contagious disease outbreak detection and containment, although it is an initial step in improving their comfort. Nonetheless, comfort may not directly translate to competence. An objective quiz at the end of the fourth year might reveal whether the three-hour mandatory workshop is sufficient for knowledge. Despite this, imparting general knowledge to all graduating medical students is an important endeavor. The two-week course is recommended for physicians pursuing emergency medicine and primary care specialties, as they will most likely be the first to encounter an outbreak.

4. What are the next steps regarding developing a joint curriculum on creative ways to teach this topic?

   We propose the formation of a consensus group of medical educators who will develop and validate creative methodologies for teaching this topic in an efficient fashion. The use of bio-simulators and web or DVD-based curricula in undergraduate and graduate medical education should be explored as teaching tools. At our institution, as at most, there is adequate time but little geography in the fourth-year medical student curriculum. Not all students participated in the mandatory workshop because they fulfilled their emergency medicine requirement at another institution. Therefore, a web-based curriculum (two to three clinical scenarios followed by self-assessment quizzes graded online) would reach all students, not just those who participated in the workshop. A primary online course may also be a desirable alternative for institutions that could not otherwise add this training to their curriculum due to logistical reasons or time constraints.

The fourth-year curriculum offers the opportunity for an elective course in Emerging Infectious Diseases and Bioterrorism for those especially interested. While the principles of infection control and empiric antibiotic treatment apply to all postgraduate physicians, those students pursuing the fields of emergency medicine and the primary care specialties (internal medicine, family practice and pediatrics) would benefit from the opportunity to participate in an experiential exercise in biopreparedness using a clinical simulation center.
Table 2 EMERGING INFECTIOUS DISEASES AND BIOTERRORISM: Proposed Curriculum

Day 1: General infection control practices
Case-based presentation of meningococcal disease: Students work through a clinical case of a patient who presents to the Emergency Department with fever and altered mental status and develops a purpuric rash
Syndromic surveillance strategies: Discussion of national and international surveillance systems and public health reporting; emphasis on requirements for mandatory reporting. Internet resources in the event of an outbreak [Centers for Disease Control (CDC), World Health Organization (WHO), United States Army Medical Research Institute for Infectious Diseases (USAMRIID)]

Day 2: Emerging respiratory infections: SARS and Avian flu
Disaster planning and preparedness; emphasis on treatment and care of close contacts of those infected and the “worried well,” multiple examples and review of recent literature, emphasis on zoonoses and global outbreak reporting mechanisms as a means for tracking novel and re-emerging infectious diseases worldwide.

Day 3: Approaches to general disaster planning and response
Emphasis on the Incident Command System, hospital disaster plans; use of real-life examples such as Hurricane Katrina.

Day 4: Media training for disaster response: What to expect when talking to the media, small group scenarios with scenario critiques

Day 5: Bioterrorism
An overview of category A, B, and C bioterrorism agents, with an emphasis on diagnosis, clinical features, therapeutic and prophylactic interventions, and transmission and containment principles.

Food-borne illness: Discussion of common enteric illnesses such as staphylococcal food poisoning, clostridium perfringens, the hemorrhagic diarrheas (salmonella, shigella, Ecoli O157:H7), cholera, and listeria; discussion of diagnostic strategies and epidemiology principles of food outbreak investigation; discussion of infant diarrhea worldwide and WHO’s recommendations for oral rehydration therapy.

Day 6: Biosafety
Discussion of the principles of bio-safety in the hospital and laboratory environment, discussion of biosafety (BSL) levels and personal protective equipment; tour of BSL-3 laboratory (which involves work with infectious agents which may cause lethal disease via inhalational exposure), if available, with demonstration of safety features of cabinets and air filtration.

Personal preparedness: Lecture on what families can do at home to prepare themselves in the event of a disaster, including what materials to stockpile, and developing an evacuation or emergency plan.

Day 7: Case studies in Emerging and re-emerging infections
Tuberculosis and Hemorrhagic fevers: Case-based presentation of tuberculosis, based on CDC guidelines; case-based presentations of Marburg and Ebola virus, with an emphasis on Congo outbreaks, public health infrastructure breakdown, role of WHO and CDC, diagnostic and therapeutic strategies, and containment.
Based on what we taught and feedback from students complete the workshop surveys on topics they would be most interested in hearing about, we have developed a proposed didactic course outlined in Table 2.

Beyond Undergraduate Medical Education:
Teaching Contagious Disease Outbreak Education to Residents - Residents spend the vast majority of their time providing clinical care. With limited time and resources, a three-hour workshop directed at those most likely to encounter an outbreak (residents in Emergency Medicine, Internal Medicine, Pediatrics and Family Practice) would be most efficient. The contagious disease outbreak workshop as described in this article can be adapted to residents’ expected level of knowledge (e.g., infectious disease fellow versus surgical intern) and reinforced by web-based cases with self-assessment tools. The workshop as a simulation exercise addresses the ACGME core competencies of patient care, systems-based practice, and practice-based learning. Due to the limited number of residents who were invited to participate in our study, more research is needed on the effectiveness of a limited workshop compared to a more comprehensive course.

Traditional bioterrorism courses geared toward healthcare providers are usually competency-based and emphasize specific tasks required of individual healthcare providers. Although the Centers for Disease Control continues to develop and put forth web-based training programs and public health conferences addressing both topics in bioterrorism and emerging infections, these are geared to national first responders and public health employees who have specific job descriptions. There is indeed a difference between educational and occupational training. The majority of these programs do not address general education in contagious disease preparedness for clinicians in training. A coordinated multidisciplinary approach that builds on basic science concepts is needed to incorporating this topic in educational curricula. Adult learners such as medical students and residents need to understand the usefulness of devoting time and effort to learning; therefore, programs developed for clinicians in training should promote active learning and self-motivation.

Other Educational Endeavors to Teach Bioterrorism and Emerging Infectious Diseases - The AAMC guidelines recommend a combination of didactic experiential learning to teach bioterrorism and emerging infectious diseases. Cassoobhoy et al. implemented an interactive bioterrorism and emerging infections course for medical students and internal medicine residents in cooperation with public health officials. Using a real-time simulation model, a modified version of a public health table top exercise, they found that knowledge improved after the course. In 2003, a government-funded collaboration of public health departments and academic centers used standardized patients and computerized biosimulators as well as moulage, a realistic make-up technique to display wounds or lesions on standardized patients. Unfortunately, the use of such advanced technology such as moulage and biosimulators is beyond the resources of most medical schools.

The military has been at the forefront of bioterrorism training. A collaboration between a military institute and an academic center created an eighteen-hour course for second year medical students on the resources available in the event of a disaster, resource management, specific

Table 2 Continued:

Malaria: A comprehensive review of clinical features, diagnostic strategies (including new field tests), treatment and prophylaxis, including for drug-resistant malaria; discussion of the epidemiology of malaria, illustrated by clinical case examples.

Dengue fever: Emphasis on vector-borne illnesses and changing habitats.

Day 8: Nosocomial disease
MRSA and VRE: Discussion with Infection Control and review of lab testing with Microbiology, including infection control measures and susceptibility testing; discussion of community-acquired MRSA, including epidemiology and treatment strategies

Days 9 and 10
Student group project presentations: an opportunity for students to focus on a subject of interest or a topic not covered in the didactic.

Based on what we taught and feedback from students complete the workshop surveys on topics they would be most interested in hearing about, we have developed a proposed didactic course outlined in Table 2.
bioterrorism agents, and the psychosocial impact of disasters. A combination of lectures, experiential exercises and simulated modules were found to be most valuable and post-test questionnaires demonstrated improvement in knowledge. While worthwhile, the time-intensive, concentrated format is probably not feasible given the time constraints and limited resources of most medical schools. The authors put forth as one of the challenges the integration of the curriculum vertically through all four years of the curriculum as mandated by the AAMC.  

A shorter curriculum similar to the workshop presented in this article may improve knowledge regarding a contagious disease outbreak. Gershon et. al. showed that a brief three-hour course is associated with a change in knowledge and attitude regarding bioterrorism. More studies on the effectiveness of a contagious disease outbreak workshop for students and residents are needed to improve educational strategies in teaching outbreak preparedness.

Although we did not employ standardized patients or the biosimulator for teaching outbreak preparedness, these could be used to teach agent-specific syndromes and therapeutic interventions. The use of simulation techniques such as standardized patients is already being used to train students on physical examination skills and physician-patient communication in both graduate and undergraduate medical education. With simulation models, lifelike mannequins are programmed to react to and execute interventions in real time. Our institution already uses a biosimulator to teach Advanced Cardiac Life Support (ACLS) and critical care to emergency medicine residents and fourth year medical students. In addition, standardized patients could be used to teach effective communication about the psychosocial impact of an outbreak, an area in which clinicians have typically performed poorly. A training program at the University of South Florida to promote homeland security via training professionals and the community assessed participant evaluation after the first year of the program and found that there was a need for more interactive sessions. Standardized patients as well as focus groups and case-based scenarios would be one way to provide this interaction.

Limitations of Our Study - Approximately half of the fourth-year medical students completed the Practice of Medicine surveys for both 2005 and 2006. Although we feel this is a good response rate for this group, the results may not be representative of the entire class. Although there are no ideal tools for assessing outbreak preparedness, self-reported knowledge may not reflect students’ actual preparedness in the event of an outbreak.

The fourth-year students having taken the Emerging Infections course were more comfortable with both detection and containment than those who had participated in the workshop only. These results may be biased by three factors:

1) The Practice of Medicine Survey was completed only two weeks after the completion of the course.

2) Students opting to take the course were presumably more interested in infectious disease, with increased baseline knowledge and motivation to learn this topic.

3) Most students who had taken the Emerging Infections course had also participated in the three-hour workshop.

Conclusions

Most residents and students at our institution felt that outbreak preparedness was not adequately addressed in their respective curricula and almost all wanted more instruction. As educators in the Nation’s Capitol, we feel that this training is particularly important for our students and residents. Given that outbreak reporting and hospital disaster plans are not discussed in other areas of the curriculum, the real-life nature of the workshop is effective in simulating an outbreak scenario and may help students navigate resources, call appropriate consultants, and interact with hospital administrators in the event of an outbreak, as well as facilitate awareness of their hospital’s outbreak plan. Integrating emerging infections preparedness into current curricula relies on emphasizing its importance and creativity in curricular design. We feel that even brief training sessions are better than none, and that integration and reinforcement through various courses and clerkships will lead to better prepared clinicians.

Based on the results of our study, we propose integration of a three-hour workshop with other instructional endeavors in emerging infections and biopreparedness into medical education curricula. We propose collaboration between institutions to further research on improving educational strategies and methods of participant assessment. We recommend the offering of a more comprehensive course for those pursuing emergency medicine and the primary care specialties, as they will be the most likely to encounter an outbreak.

We are in the process of developing a web-based version of our didactic course that will cover the basic principles of bioterrorism and infectious disease outbreak management. The web-based course will be offered to
all medical students and residents and will offer added flexibility in order to further enhance course participation. An online course may be a desirable alternative for institutions who could not otherwise add this training to their curriculum due to logistical reasons or time constraints.

We welcome any suggestions for improving on this curriculum that may lead to a consensus conference for joint curricular design in emerging infections and biopreparedness.

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