Educating Health Professionals to Respond to Bioterrorism

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SYNOPSIS

In September 2003, a consortium of bioterrorism and health education experts from the University of Louisville, the University of Kentucky, the Kentucky Department for Public Health, and the Louisville Metro Health Department received funding from the Health Resources and Services Administration (HRSA) to develop a broadly based bioterrorism education program for health professionals in the Commonwealth of Kentucky and the surrounding region. This grant will fund a series of presentations tailored to the needs of professionals in medicine, dentistry, public health, nursing, behavioral medicine, allied health, pharmacy, veterinary medicine, and agriculture, providing coordinated training both on site and through distance learning technology. This article outlines the major grant-funded activities envisioned for the grant years 2003 through 2005, focusing on the use of standardized patients and computerized biosimulators, the transdisciplinary partnerships of the universities involved, and the essential collaboration provided by the state and local health departments.

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The threat of bioterrorist actions against citizens of the United States has generated an extensive plan for detection and response involving several components of our health care system. It is essential that both physicians and an extended array of health professionals—such as public health personnel, dentists, nurses, behavioral health specialists, pharmacists, veterinarians, and agricultural experts—be included as an integral component of this vital network.

The education of this broad range of personnel is necessary to provide early warning of the sentinel wave of illness occurring after an exposure to a bioterrorist event and prior to the occurrence of a second wave of cases. Persons with acute infectious diseases are unlikely to have direct access to subspecialists; they are more likely to be managed initially by frontline providers who serve as gatekeepers to subspecialty care. Referrals of such individuals to infectious disease experts are likely to require additional time, and such delays may result in many more cases occurring before the source can be identified and contained. Under such circumstances, it is critical that frontline health professionals in the affected areas be aware of:

- Syndromes or disease patterns suspicious for biological warfare agent exposures;
- Sources of detailed educational materials for use as just-in-time resources;
- How to collect, transport, and submit relevant specimens;
- Mechanisms for notifying local authorities rapidly about the event;
- Preferred modes of treatment, patient handling, considerations for transfer and isolation, indications for quarantine of the exposed, and screening for early signs of illness;
- Approaches to large-scale immunization of populations, sources of rarely used vaccines, other immunobiologic agents, and antibiotic or antiviral agents for use in pre- and post-exposure prophylaxis as well as for treatment; and
- Methods of interacting with local and state experts or electronic information systems to ensure appropriate treatment and the tracking of outcomes following exposure.

NEW INITIATIVES IN CLINICIAN TRAINING

The first and arguably most important challenge for frontline health personnel is recognition of syndromes that might represent exposure to biothreat agents among patients presenting for evaluation. While traditional didactic lectures provide an important foundation of knowledge in this regard, there are limits to the standard classroom approach. Photographs provide only a two-dimensional representation of skin lesions and may be affected by problems with reproduction of color. Written descriptions are even more limited. Standardized patients and computer-driven biosimulators are two techniques that will be used to help train clinicians in detection of bioterrorist-related syndromes.

Standardized patients

The use of standardized patients offers a substantial improvement over slides and other photographic representations of disease manifestations. Standardized patients (SPs) are educators who are highly trained using well defined protocols in the symptoms of specific diseases. When queried, they deliver standardized responses to specific questions, following the educational scenarios developed by the faculty. They are also trained to provide feedback to the examiners following the encounter. Using written scripts, they are taught to accurately and consistently recreate the history, personality, physical findings, emotional structure, and response patterns of actual patients, and they receive ongoing training to ensure standardization and strengthen realistic case portrayal. Learners are exposed to these patients during their training to assess skills, provide feedback, and identify areas for improvement. Under such conditions, they experience what it is like to examine “real” patients in an entirely risk-free environment. In studies where unannounced standardized patients are used with experienced clinicians, nine times out of 10 those clinicians cannot determine which patients are standardized and which are “real.”¹⁻⁶

Each SP can be made to look as though they have manifestations of disease—especially dermatologic—through the use of a sophisticated makeup technique known as moulage, applied by trained experts (Photo 1). Moulage allows for a true three-dimensional display of lesions with tactile accuracy. For example, in the case of smallpox lesions, the vesicles can be made to appear clear or opalescent, round or umbilicated, discrete or confluent, depending upon the stage of the disease (Photo 2). They can also be given different degrees of firmness, representing the indurated and well marginated lesions typical of this disease. Moreover, diseases that may be confused with smallpox, such as monkeypox⁷ or chickenpox, can be represented in different patients so that the learner is able to directly compare all aspects of the eruptions that help distinguish the diseases. For example, chickenpox lesions are much more superficial and asynchronous in development, such that neighboring lesions on the same skin surface may be in the macular, papular, vesicular, pustular, and scab phases of disease at the same time. This is in stark contrast to smallpox, where all lesions are in the same phase of development at the same time.⁸ The relatively unusual but generally fatal variants of classic smallpox, known as flat and hemorrhagic smallpox, can readily be represented as well. In addition, the cutaneous stages of response to immunization have also been simulated for use in the 2003 campaign for vaccination of frontline health personnel against smallpox. Those involved in grading the response to vaccination found it useful to see the normal variation in dermal response and to feel comfortable distinguishing a more pronounced local response from a pathological response, such as progressive vaccinia.

Bioterrorism-associated cutaneous anthrax has already been encountered by clinicians following the well documented exposures of late 2001.⁹ This disease presents an easily recognizable clinical picture several days after eruption,¹⁰ but can be difficult to identify early in the course of illness. Moulage techniques allow for simulation of all phases

Photo 1. Application of moulage provides realistic simulation of dermatologic manifestations of disease.

of the lesions using the same or different patients (Photo 3). Viewing the evolution of the lesions makes it simpler to recognize that what may appear to be either a brown recluse spider bite or cutaneous hypersensitivity reaction may actually be early anthrax, thereby prompting the learner to incorporate this otherwise obscure infection into the differential diagnosis of such eruptions. Subtle color variegations, surface irregularities, fluid exudation, and patient response to palpation may all be readily simulated using this approach.

Viral hemorrhagic fevers, particularly Ebola, are especially feared potential biothreat agents due to their largely inexorable course, leading to death and unresponsiveness to available antiviral agents.¹¹ While American physicians may be aware of outbreaks of Ebola occurring in the equatorial regions of Africa, few are familiar with its characteristic findings during the initial presentation of disease. One of the most challenging clinical signs to recreate is hemorrhagic conjunctivitis. This is accomplished using special contact lenses that simulate subconjunctival hemorrhages. Fresh blood exuding from the nose and mouth, around intravenous catheters, and from venipuncture sites can be readily simulated using various forms of theatrical stage blood. The appearance of hematemesis can be recreated using capsules containing stage blood that are hidden inside the mouth

and bitten, expelling a sanguineous fluid at the time of examination. Together with a carefully crafted performance by the standardized patient to recreate lassitude, orthostatic dizziness, and confusion, the entire clinical presentation involving hemorrhagic lesions at a variety of sites becomes a dramatic image not likely to be forgotten by the examiner.

Biosimulators

One of the newest technologies for teaching the management of patients exposed to biothreat agents involves the use of computer-enhanced biosimulators (Medical Education Technologies Inc., Sarasota, FL). These lifelike mannequins can be programmed to react to toxin or infectious agent exposures in a manner that duplicates human response. Physicians may thus test their skills in treatment in a situation where there is no harm posed to a live patient (Photo 4). Simulation is especially helpful in rapidly evolving or emergent clinical situations wherein failure to intervene appropriately could result in the death of the patient. Inhalational anthrax with resulting mediastinitis and hemorrhagic pleural effusions can be recreated readily in the simulation laboratory based on descriptions in the recent literature.¹² Physicians would be expected to suspect the disease based on a radiograph showing a widened mediasti-

Photo 2. Early phase of smallpox simulated on the face of a standardized patient.

num in the absence of blunt chest trauma or other evidence of an aortic aneurysm. If their choice of antibiotics (e.g., ciprofloxacin) is not correct, the mannequin will develop signs of septicemia with circulatory collapse, triggering yet another set of management responses from the clinician being trained.

Both clinician recognition and management of botulinum toxin exposure can be measured using a combination of these two technologies. Standardized patients may be used to recreate symptoms of dysphonia, pharyngeal dysphagia, and dyspnea as well as findings of cyanosis, all suggestive of early botulism.¹³ Once the presumptive diagnosis and need for admission of the patient to an intensive care unit has been established in the SP clinic, the examiner can be moved to the simulation center for evaluation of delivery of definitive care. Dysfunction of the cranial nerves with papillary dilatation, disconjugate gaze, dysphonia, and hypoventilation may all be programmed into the mannequin's response, with the goal of determining whether prompt intubation and ventilatory support are rendered. Decision-making regarding use of botulinum antitoxin as well as testing for hypersensitivity and simulation of anaphylaxis to this equine-derived product can all be assessed readily and safely in this setting.

DISTANCE LEARNING

Outreach to health care professionals using distance learning technology is particularly important in this rural state, especially in the eastern Appalachian region. Kentucky is divided into 120 counties and is characterized by small city-rural demographics, infrastructure, and culture. Fully 56% of Kentuckians live in non-metropolitan areas, compared to 19% of the population nationally. The Preparedness and Response on Advanced Communications Technology (PROACT) network is a subset of 16 sites from the Kentucky Telehealth Network (KHTN), a statewide telehealth initiative co-managed by the University of Kentucky and the University of Louisville, that are committed to providing the state's Department for Public Health emergency access to network sites around the clock, 365 days a year. The network is committed to being active within hours of initial contact,

allowing direct visual contact between public health officials, community clinicians, and experts from across the nation. PROACT will serve as the primary medium through which the grant's distance learning activities are conducted. It will also serve as a means of regular communication with the state's 16 bioterrorism coordinators, conducting statewide or regional disaster exercises, and performing critiques of those exercises with the involvement of national experts.

TRAINING OF OTHER HEALTH PROFESSIONALS

While the description of program activities thus far has focused on clinicians, many types of health professionals are being trained under this grant. Faculty at the University of Louisville's School of Dentistry and School of Public Health and Information Sciences and the University of Louisville Hospital's Infection Control Office, together with faculty at the University of Kentucky's colleges of Medicine, Pharmacy, Social Work, and Agriculture, have participated in a series of lectures targeted at practitioners in their specialty areas.

Dentistry

Dentistry has an important role to play in the response to any significant bioterrorist attack, as noted by the American Dental Association's chief policy advisor.¹⁴ While current efforts to educate and utilize dental professionals in an emergency situation concentrate on forensic identification of victims, faculty at the University of Louisville are training dentists and dental hygienists in an expanded capacity as responders to a mass casualty event, in the context of the Metropolitan Medical Response System (MMRS). The School of Dentistry's facility, with its electronic classrooms and state-of-the-art simulation clinics, will be used to train MMRS volunteers from all health professions. Dentists and dental hygienists will be presented with a special array of standardized patient simulations focusing on intra-oral pathology and orofacial manifestations of infection due to biothreat agents. Given that the initial manifestations of clinical illnesses resulting from biothreat agent exposure, particularly smallpox, may be in the form of oral lesions, such training is particularly critical. Moreover, dentists and dental hygienists will be trained in

Photo 3. Early, intermediate, and late phases (from right to left) of cutaneous anthrax can be recreated using advanced moulage techniques.

Photo 4. Computer-driven biosimulators are used to teach health professionals how to manage inhalational anthrax or botulism with no risk to patients.

non-traditional roles in order to expand the surge capacity of local disaster responders, particularly in the distribution of pharmaceutical agents for post-exposure prophylaxis. Using face-to-face and distance learning technology provided through the Kentucky Telehealth Network, a total of 32 hours of dental continuing education credit will be available in the areas of bioterrorism awareness, recognition, assessment, and response.

Pharmacy

Pharmacists have frequently been neglected in the implementation of educational programming; however, their role in the nation's response to bioterrorism could be particularly important given their involvement with the management of the Strategic National Stockpile and the need to participate in the distribution of medications to citizens after a major exposure.¹⁵ Community and hospital-based pharmacists in Kentucky are being offered a series of five lectures with the opportunity to receive certification in bioterrorism preparedness. The curriculum of this program consists of five one-hour modules, including the following topics: small-

pox/viral issues and treatment; anthrax/plague/bacterial issues and treatment; organophosphates/nerve gases; the Strategic National Stockpile; and local/regional/state responses to bioterrorism. Courses will be taught twice on the same day, in the early morning and early evening, to accommodate a variety of work schedules.

Veterinary medicine and agriculture

Given the national concerns about possible agroterrorism (agricultural bioterrorism), manifestations of bioterrorism that might first appear among animals and plants must also be addressed in bioterrorism training.¹⁶ Agriculture is the largest industry in Kentucky. Its beef production is the largest of any state east of the Mississippi and results in about \$4.5 billion in revenue annually; consequently, an attack on the food supply could have disastrous health and economic consequences for the state. It is also home to a major equine industry, most notable for its large number of farms breeding thoroughbred horses. In response to this threat, a cadre of veterinarians, veterinary technicians, and agricultural extension agents will be trained to deal with agroterrorism.

The value of agricultural extension agents in taking important public health information to rural communities has been well documented.¹⁷ The educational offerings will include presentations on plant microbiology, early recognition of biothreat-related zoonoses and botanical diseases, pests related to biosecurity, the agricultural extension agent as county plant health doctor, and food supply safety.

BEHAVIORAL HEALTH

An extensive program is also being designed to address the potential impact of bioterrorism on the mental health of the population. All licensed behavioral health professionals in Kentucky will be offered the chance to participate in a curriculum being designed specifically for this purpose. At present, there is essentially no existing database of empirical literature on the mental health effects of bioterrorism that might serve to guide preparedness, response, and recovery efforts.¹⁸ Consequently, a customized curriculum is being designed for outreach to even the most remote mental health professionals through videoconference networks. Training modules will focus on the surveillance and early identification of persons experiencing distress due to exposure to the ongoing threat of bioterrorism, crisis stabilization and referral services, and early intervention with cognitive-behavioral therapies. Emphasis will be placed on the needs of the most vulnerable members of society, especially children and the elderly.

HEALTH DEPARTMENT COLLABORATION

Both the state and local health departments are intimately involved with the grant's training activities. Health department leaders will give presentations at statewide public health meetings and via the PROACT network, emphasizing the integration of effort from all health professions into the recognition, reporting, and response to bioterrorism. The need for communication to the local health department when suspicion exists regarding a biothreat-related exposure, the threshold for notification, the systems of electronic surveillance for unusual disease patterns in the population, the relationships among local, state, and federal agencies in the face of a confirmed event, and the appropriate collection and submission of specimens to the state's public health laboratories for confirmation of disease are focal points of such presentations.

The development of an extended public sector-academic partnership in Kentucky has been essential for the creation of a statewide biodefense network. By dividing responsibilities for focused training into areas of special interest and expertise at the two universities, the Kentucky Department for Public Health, and the Louisville Metro Health Department, the full range of objectives for continuing professional education is being accomplished. In the process, historical issues of competition are being overcome in order to provide essential educational offerings. Access to these unique programs is being extended across the common-

wealth through the use of the PROACT network, providing professionals in the most remote parts of the state the opportunity to receive fully updated information. During the next phase of activities, we intend to greatly extend the reach of these activities beyond our region through the use of web-based education, establishing the opportunity for immediate learner-directed video interaction with standardized patients.

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