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BUILDING COMMUNITY-BASED SURGE CAPACITY THROUGH A PUBLIC HEALTH AND ACADEMIC COLLABORATION: THE ROLE OF COMMUNITY HEALTH CENTERS

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To improve national emergency preparedness, multiple levels of the public health system require strengthening. One major area is surge capacity,[1] defined by the Agency for Healthcare Research and Quality (AHRQ) as "a health care system's ability to rapidly expand beyond normal services to meet the increased demand for qualified personnel, medical care, and public health in the event of bioterrorism or other large-scale public health emergencies or disasters."[2] The aftermath of Hurricane Katrina and increasing concerns about a possible avian flu pandemic have focused more attention on this issue, especially regarding disadvantaged and special needs populations.[3] While national agencies such as AHRQ, the Centers for Disease Control and Prevention (CDC), and Health Resources Services Administration (HRSA) have cited surge capacity as a priority "focus area," current published literature is sparse. A MEDLINE search yielded few relevant resources, and those focus primarily on hospital settings.[4,5] Non-hospital settings, such as community health centers (CHCs), also offer potential. In this article, we describe a collaboration among CHCs, government agencies, and academia that initiated the growth of community-based surge capacity in the Boston area.

DEFINING THE DIMENSIONS OF SURGE CAPACITY

The dimensions of surge capacity include *health care facility-based surge capacity*, *public health surge capacity*, and *community-based surge capacity*.[1] *Health care facility-based surge capacity* refers to the ability of health care facilities to treat increased numbers of sick and injured, especially when inpatient care is required. *Public health surge capacity* refers to the capacity to implement core public health activities such as mass prophylaxis and vaccination, risk communication and epidemiologic investigation. *Community-based surge capacity* encompasses the community's ability to supplement both the public health response (by assisting with mass care initiatives such as vaccination or prophylaxis) and the health care facility response (by providing care at sites away from overloaded facilities). A United States General Accounting Office (GAO) report notes that much remains to be accomplished in these areas.[6] Groups such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) have urged ". . . an agreed-upon set of units, or measures, of surge capacity at the federal level or, at the very least, at the state level . . ."[1,7] for facility-based surge capacity; HRSA has established an ad hoc surge capacity target of 500 extra hospital patients per million population in urban areas.[8] Similar targets, lacking for community-based surge capacity, are needed with respect to *space, staff, and supplies.*

Space considerations include temporary external shelters (e.g., the Louisiana Superdome in the case of Hurricane Katrina) and sites for patient triage (such as schools/public buildings/hotels or even partially decommissioned hospitals).[9] Public health officials are trying to identify facilities that ideally could accommodate high traffic volume and have capacity for decontamination, showers, waste disposal, heating, plumbing, water, sewage systems, electricity, and parking. *Staff* includes not only medical personnel (e.g., physicians, nurses, and trained interpreters) but also those with key coordination functions (e.g., contacting service organizations, aiding in volunteer recruitment, and coordinating volunteers and off-duty personnel in

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the logistics of care), as well as those providing administrative support (e.g., patient tracking, clinical management, and triage). A local medical reserve corps (enhanced by just-in-time training) could help staff an off-site facility, particularly in the first several days of a crisis. *Supplies* include local stockpiles of equipment (e.g., medications, vaccinations, and personal protective equipment), the strategic national stockpile, and communication and information network supplies (e.g., radios and computers). Supply issues also include cooperative mutual aid agreements with other health care facilities and material management issues (ranging from refrigeration of pharmaceuticals to maintaining paper supplies, computers, and copiers in functioning order).

COMMUNITY HEALTH CENTERS AS A FOCUS FOR COMMUNITY-BASED SURGE CAPACITY

First established in 1965, community health centers have as a core mission the commitment to serve clients regardless of income, insurance coverage, or immigration status. Currently, the nation's network of over 1,000 federally qualified health centers (nonprofit, consumer-directed health care corporations that provide comprehensive primary and preventive health care services) serves 15 million people.[10] Moreover, CHCs have special commitments to underserved and immigrant populations. In 2002, two-thirds of all federally funded health center patients were members of racial and ethnic minority populations, 86% were low-income (i.e., family income ≤200% of the federal poverty level), approximately 40% had no health insurance, and approximately one-third spoke a primary language other than English.[11]

CHCs are organized under the umbrella of Primary Care Associations (PCAs), non-profit associations representing health centers and other primary care (safety net) providers on a state or multi-state regional basis. PCAs provide a variety of services in support of community-based primary care, including centralized clinician recruitment and technical assistance in areas of programs, management training, and governance. CHCs have close affiliations with hospitals and/or operate under hospital licensure.

CHCs represent a unique focus for community-based surge capacity because of their potential contributions to patient care and public health during emergencies. As a usual place of care, CHCs constitute sites where patients may present in the first stages of a disaster such as the anthrax and SARS episodes.[12–14] CHCs are usually accessible by foot or public transportation in the communities they serve. CHCs could also potentially serve as points of dispensing for mass vaccinations or prophylaxis. Multicultural/multilingual providers and support staff of CHCs can facilitate communication and rapid interventions where language barriers or mistrust of the health care establishment may be high.

Even before 9/11, the Department of Defense envisioned that Neighborhood Emergency Help Centers could provide "a network of high-volume temporary care facilities that can rapidly enhance a community's 'surge capacity' to more effectively manage immediate medical and human service needs. . . ." and ". . . serve as rapid neighborhood triage centers and dispensaries."[13,15] Also, the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (H.R. 3448; PL 107-188) specifically authorized funding "for the purpose of enhancing the preparedness of hospitals, . . . clinics, health centers, and primary care facilities for bioterrorism and other public health emergencies."[16]

However, several national surveys by the National Association of Community Health Centers (NACHC) documented a need for better planning and preparation.[12] The October 2001 NACHC survey of PCAs and CHCs (including responses from 137 federally qualified health centers) found that "health centers were willing to participate in responses to these threats, but that they lacked adequate resources . . . including drugs, supplies, training, and information systems."[10] Furthermore, a 2003 NACHC survey found that ". . . only a handful said that health centers also had representation on [advisory] committees."[14]

An October 2003 NACHC disaster preparedness survey of health center executives (193 responses; total response rate of 27%) underscored both the potential and challenge of building surge capacity through CHCs.[13] The majority (76%) of respondent CHCs indicated that they had written emergency or disaster plans. However, only about half had contacted and/or coordinated with their local, county, or city health departments, and just 28% with state health departments. Only 30% had received training from the local health department, 28% from the state health department, and 18% from the local Emergency Medical Services (EMS). Only 9% of responding health centers felt adequately prepared for a community disaster; they identified training and improved equipment and supplies as high priorities.[13]

INITIAL PLANNING AND IMPLEMENTATION OF PREPAREDNESS TRAINING FOR BOSTON COMMUNITY HEALTH CENTERS

In Massachusetts, 53 CHCs at 185 sites serve one out of every ten state residents.[17] HRSA's Bureau of Primary Health Care recognizes the Massachusetts League of Community Health Centers ("the League") as the state's PCA. These CHCs care for about 43% of the state's medically underserved (defined as Medicaid-eligible and low-income uninsured and underinsured).[17]

The impact of CHCs is particularly striking in Boston, a major metropolitan city with great diversity; 51% of its residents are non-white.[18] Each of the city's 26 CHCs tailors services to meet the needs of populations that are traditionally underserved. These centers offer a wide range of services, including primary care, pediatrics, obstetrics and gynecology, immunizations, dental care, mental health, social services, community outreach, and public health programs.

In winter 2002–2003, the Boston Public Health Commission (BPHC) and the League launched a staged process of clarifying expectations and roles through planning meetings. (Personal communication, R. Serino, Boston Emergency Medical Services, May 9, 2005.) A League survey of 37 CHCs in Massachusetts found that about three-fourths had written emergency plans and about half had updated them since 9/11.[18] About two-thirds had the resources to staff facilities beyond normal operating hours, but only about a third of clinical staff had received some training in disaster preparedness. Virtually all identified personnel training, obtaining personal protective equipment, and participating in the local communications network as their highest priorities.

Responding to these needs and initiating the process of building community-based surge capacity first required role clarification. Many CHC leaders and staff expressed initial concern that they would be expected to handle hospital overflow patients requiring acute care. CHC leaders and staff were subsequently reassured that they would be expected to continue to focus on providing primary care and ambulatory care. Discussions ultimately solidified the understanding that key CHC roles as part of emergency preparedness could include: (*1*) surveillance of unusual outbreaks and diseases; (*2*) education of community and patients; (*3*) internal staff education, as well as clarification and identification of staff roles; (*4*) vaccination and mass prophylaxis; (*5*) capacity to address post-event public demands/needs; (*6*) outpatient surge capacity and triaging systems; and (*7*) an integrated role in city-wide emergency response efforts.[19]

In March 2003, BPHC initiated the first of three rounds of pilot funding to tailor emergency preparedness plans according to each CHC's capabilities and responsibilities. BPHC provided CHCs with a self-administered assessment tool to document needs and refine their plans. Some critical elements included establishing policies for calling in staff, clarifying whether emergency response duties were voluntary or part of a job description, and creating communication phone trees.

In addition, BPHC, Boston Emergency Medical Services (Boston EMS) and the DelValle Institute for Emergency Preparedness (a BPHC and Boston EMS program funded by the CDC and the Massachusetts Department of Public Health) provided basic training regarding emergency operations planning and the incident command system (ICS). Several CHCs went further by initiating coordinated planning with other CHCs in proximity. At the end of this pilot period, each participating CHC submitted to the BPHC a final report of activities accomplished and resources needed to continue to grow this effort.[20]

City-wide planning in 2003, highlighted by two day-long summits, brought together key decision-makers from hospitals, public health, CHCs, and emergency medical services. For many CHCs, these summits presented the first tangible opportunity to participate with other organizations as part of the surge capacity planning process. The summits reemphasized the role of CHCs in emergencies, as evidenced by their dedicated seat at the Boston Emergency Operations Center alongside public health, EMS, and hospital representatives.

In October 2003, the Harvard School of Public Health Center for Public Health Preparedness (HSPH-CPHP) joined with Boston EMS and the DelValle Institute for Emergency Preparedness to advance training. After formalizing a memorandum of understanding, the partners developed more detailed needs assessments, designed and developed curricula, provided educational programming, and organized outreach and promotion.

First, staff from BPHC, the DelValle Institute, and HSPH-CPHP further surveyed the 26 Boston CHCs to assess desired training topics and training formats (on-site training, train-the-trainer, and centrally located training with other centers). Written surveys were followed by telephone surveys with CHC CEOs, with 15 responses. The nature of the responses varied. CHCs without prior experience in emergency preparedness desired basic training (on topics such as Emergency Operations Planning and ICS) while others desired expert feedback on established plans. Respondents ranked Exercise and Drill Design and Evaluation as

their highest priority (mean score of 3.5 on a priority scale of 1 [highest priority] to 9 [lowest priority]). All respondents wanted to improve connections with other emergency preparedness partners (such as hospitals, EMS, fire, and police). On-site training was the preferred modality, while many also favored a train-the-trainer model with short (one hour) presentations and supporting materials for CHC staff.

Based on this information, the DelValle Institute, HSPH-CPHP, and outside experts created and implemented a basic curriculum of six training seminars (*Introduction to Disaster Planning, ICS for Health Centers, Emergency Operations Plan Evaluation Tool, Emergency Operations Plan Clinic, Designing and Evaluating Exercises and Drills, and Train the Trainer).* Most modules lasted from two to four hours. *ICS for Health Centers* specifically addressed the challenges of disaster response within the context of scarce resources and minimum staffing levels seen at many CHCs. Representatives of five CHCs also participated in the city-wide surge capacity tabletop exercises along with partner hospitals. Trainings brought together Boston CHCs with their partner hospitals as well as with first responder agencies such as police, fire, and EMS. Satisfaction with training was high; almost all CHC trainees responding to evaluation surveys agreed that they had "gained new skills and knowledge" (e.g., 17/20 for *Train the Trainer* and 17/18 for *Designing and Evaluating Exercises and Drills*).

In addition to these external trainings, CHC officials used these materials for internal training of their own staff on topics such as emergency operations plan, stress management, and infection control measures. Several CHCs offered educational programs to their patients. BPHC and Boston EMS provided each CHC an *Emergency Preparedness Toolkit* of resources, including reference handbooks, incident command charts, incident command vests, maps and demographic profiles of Boston neighborhoods, digital cameras to facilitate diagnoses and sharing of information, CD-ROMs, video tapes, and other training tools.

A second round of BPHC funding of emergency preparedness grants to the League and twenty-two Boston CHCs allowed staff to attend training seminars and purchase equipment. Some CHCs used grant funding to purchase supplies such as redundant communications devices, first-aid kits, and equipment for infection control and staff safety (e.g. masks and goggles). By November 2004, the third round of BPHC grants reflected a higher level of training sophistication to improve outpatient surge capacity with respect to triaging, mass prophylaxis, immunization, and communication. The importance of CHCs and surge capacity increased that year when the CDC funded Boston as part of the Cities Readiness Initiative (CRI). This joint initiative (between the Department of Health and Human Services, the Centers for Disease Control and Prevention's Strategic National Stockpile Program, and the Department of Homeland Security) has as its aim to increase capacity for the "timely delivery of medicines and medical supplies during a large-scale public health emergency."[21] BPHC and HSPH-CPHP have also embarked on developing a distance-learning training platform for the Boston Medical Reserve Corps which enrolls volunteers to assist in public health emergencies (www.bphc.org/volunteer).[22]

Some concrete benefits have already emerged from this collaboration and training. First, CHCs have benefited from the better coordination resulting from a "staff sharing" agreement fashioned by the Boston Metropolitan Medical Response System (a program of the BPHC) and area hospitals. In this agreement, hospitals send staff (physicians, nurses, clerks, and translators) to work for the BPHC in the event of a public health emergency. Such staff, excused from regular duties, receive liability and worker's compensation coverage. In turn, the agreement allows BPHC to guarantee a competent and appropriately licensed workforce. CHC staff have been incorporated into a more unified response for staff assistance in such instances. Second, CHC staff used preparedness training to increase protections surrounding the 2004 Democratic National Convention,[23] a national event which drew thousands of outsiders into the city of Boston. CHCs have also provided volunteer staffing for special outbreaks, e.g., when Hepatitis A clinics that were activated in response to the public's exposure to an infected restaurant worker in downtown Boston (2004) and when a Boston Medical Center-based physician contracted active tuberculosis.[24] In the latter instance, CHC staff helped in an extensive process of identifying patients exposed over the preceding six-month period. (Personal communication, M. McMahon, Boston Medical Center, September 15, 2005.) Of the nearly 1,500 patients who were identified as possibly exposed, many received primary care from Boston CHCs. CHC staff assisted in a coordinated effort of screening patients, completing screening templates, and returning information to a confidential centralized electronic tracking system. The use of multiple community sites made the screening process less burdensome for the hospital, more convenient for the patients, and allowed better surveillance and investigation of the results.

LESSONS LEARNED AND FUTURE CONSIDERATIONS

Our experience has shown the potential for collaboration between government, academia, and CHCs to begin to build community-based surge capacity. The process involved needs assessments, curriculum development, training, and outreach. First, the collaboration clarified the role of CHCs in emergency preparedness, identifying at least seven specific functions. The process also reemphasized that CHCs should have a seat and a voice at the local Emergency Operations Center while also underscoring that each CHC needs to have a clear sense of its own facility's potential for surge capacity in terms of staff, space, and supplies. Trainings, which have evolved through several stages of sophistication, not only provided education but also networking opportunities with preparedness partners. CHCs in other cities, such as New York City, have also moved toward improving community-based surge capacity.[25]

Despite this initial progress in planning and coordination, many challenges remain. While all partners are committed to perfecting and testing a citywide plan that best utilizes CHC resources, there are many ongoing issues with respect to staff, supplies, and space. Complicating factors include the varying sizes and resources of the different centers and the range of integration in disaster preparedness that individual CHCs enjoy with affiliated hospitals. Other staff challenges include limited time and resources available for training, limited or no full-time personnel devoted to emergency preparedness, and employee turnover (including an ongoing nursing shortage). Limited local stockpiles of medical supplies and the need for more backup communications systems also require future attention. More engagement of neighborhood resources (such as community group volunteers) is needed. Finally, regular tests of community-based surge capacity through exercises and drills should continue to assess capabilities and needs.

Ideally, CHCs can help provide a flexible, linked network of "reserve" health care capacity to supplement, support, and extend the efforts of acute care hospitals in their communities. Coordination through PCAs (such as the Massachusetts League of Community Health Centers) offers statewide and regional vehicles to advance these experiences throughout the country. The Boston experience offers some initial lessons learned to build stronger community-based surge capacity for the future.

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USING BLENDED LEARNING IN TRAINING THE PUBLIC HEALTH WORKFORCE IN EMERGENCY PREPAREDNESS

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Events such as the 2001 terrorist attacks in New York City and Washington DC, the subsequent U.S. anthrax exposures, the 2003 Severe Acute Respiratory Syndrome (SARS) epidemic, the 2004 tsunami in Sri Lanka, and Hurricane Katrina in 2005 that devastated the Gulf Coast speak to the critical need to prepare and train a front-line workforce that includes public health personnel, medical care professionals, first-responders, and a volunteer corps.[1] There are an estimated 500,000 people comprising the U.S. public health workforce who work at local, state, and federal agencies and public health schools. Further, it is estimated that three million people in the health care system (from hospitals to voluntary health organizations) contribute to the U.S. public health infrastructure.[1] Such a sizeable and diverse workforce, coupled with the new and constantly changing demands on public health practitioners, raises concern that the United States lacks the capacity to educate and prepare its professionals for future challenges.[2] The U.S. Department of Health and Human Services 1997 report, *The Public Health Workforce: An Agenda for the 21st Century,* recognizes this gap in education, stating that "compelling and urgent programmatic forces are making enhanced training and education opportunities for public health professionals a necessity."[2] The report further argues that distance learning may begin to bridge this gap by providing a systematic process for connecting learners with valuable resources despite being separated by time and place.

In addition to the 1997 report, a second federal report, *Who Will Keep the Public Healthy?* by the Institute of Medicine (2003), advocates the use of distance learning to train public health employees.[3] Similarly, the Office of Domestic Preparedness published the *ODP Approach for Blended Learning* in February 2003 to detail its support of "blended and distance learning" for emergency preparedness training for first responder groups.[4] This latter document provides a framework for implementing blended learning technologies and strategies that can be applied in a variety of settings for a diversity of personnel, including public health professionals.

Many federal agencies currently use distance learning effectively. It is also being used successfully in public health by: (*1*) ensuring the delivery of a consistent message; (*2*) providing flexible training in both time and place for public health employees; (*3*) helping to create a community of collaboration among colleagues, and; (*4*) presenting an excellent tool for distributing knowledge and skills.[4] This article describes the blended learning teaching methodology, provides examples of blended learning in practice, and outlines areas where future research can improve the efficacy of blended preparedness training for the public health workforce.

WHAT IS BLENDED LEARNING?

The term *blended learning* is only one of a stream of new terms that have flowed into the vocabulary of educators since the integration of computers and learning. Other words and phrases used to describe online learning include: web-based learning, e-learning, hybrid learning, flexible learning, and mixed mode learning. Some educators and information technology (IT) professionals refer to blended learning as those courses that combine face-to-face traditional classroom style teaching with online learning and reduced classroom or seat-time contact.[6] Others, such as the Office for Domestic Preparedness (ODP), have expanded that definition to include modular training content in a variety of media such as interactive video teletraining, video and web-based conferencing, web-based training, computer-based training, audio conferencing, and print-based/self-paced methods to keep pace with current needs. ODP contends that combining these alternative instructional methods with traditional delivery constitutes a "blended approach."[7] Still others define blended learning as a model that can include online instruction, mentoring/instructor-led supports, and varying sources of electronic and print media.[8] For the purposes of this article, we shall use the definition of Roval and Jordan, who describe blended learning as "a hybrid of classroom and online learning that includes some of the conveniences of online courses without the complete loss of face-to-face contact."[9]

In 2003, ODP officially adopted the blended learning strategy for the training of first responders because "resources must satisfy several million individual responders in need of initial training and sustainment training" and the organization saw the need for a more "distributed and flexible training model that is agile enough to address dynamic requirements quickly, and robust enough to reach a diverse and growing audience." More specifically, blended learning can:[7]

a. Provide accessibility in a convenient timeframe for the learner.

b. Create consistency in the content to establish a uniform baseline of information for the public health workforce.
c. Promote learner acceptance and satisfaction of instructional approach.
d. Offer repeatable opportunities for learning and simulated experience (reinforcement).
e. Provide cost-effective instruction.
f. Provide a diverse array of instructional approaches specifically targeted to the learner audience and the subject matter and skills sets to be delivered.[4,5]

A blended learning approach is student-centered and uses a selection process or tool that:

a. Combines media for maximum learning as demonstrated by measurable outcomes;
b. Promotes the use of less expensive media when it is equally effective;
c. Considers the design and production costs;
d. Is most appealing to learners;
e. Identifies the availability of supporting technology;
f. Recognizes the time constraints on learners;
g. Offers a variety of interaction through stimuli and activity.

DEMAND FOR BLENDED LEARNING

Blended learning technologies have been increasingly applied in a variety of fields, both public and private, in recent years. Universities, federal employees, and private businesses are among those employing blended learning technologies in training students and personnel currently in the workforce.[3,4,5] Of particular note is the increasing use of blended learning to train the medical and public health communities in emergency preparedness training for a variety of groups such as emergency managers, government officials, and public safety personnel.[6] In addition to "top-down" support for the use of blended learning to train the public health workforce in preparedness skills, preliminary research shows there is demand for such training. The Accreditation Council for Continuing Medical Education's Annual Report shows steady increase in growth in online participation for Continuing Medical Education (CME) activities and hours for both physicians and non-physicians from 1998–2003.[7,8] Internet CME that accounted for 2.15% of all activities and 0.60% of all credit hours in 1998[9] rose to 21.70% of all activities and 4.11% of all credit hours in 2004.[10] In addition, when nurses in a 2003 study were asked their learning preferences for emergency preparedness competencies, online web-based courses ranked second after face-to-face learning.[11]

More generally, in the 2001 National Household Education Survey by the National Center for Education Statistics, 49% of Americans participated in a post-compulsory (such as courses required by teachers after graduating to maintain certification) education activity and 53.6% of participants had an activity involving the use of technology.[12] As education level and income level rose among adults, those numbers increased. For example, 74.5% of professionals participated in a post-compulsory education activity, and 61.6% of those participants had an activity involving the use of technology.[18]

Among all users, the primary reason for acceptance of blended learning models is that the time commitments are highly flexible and allow students to take courses that would otherwise not be possible, given obligations to work and family.[13] The awarding of continuing educational units and recognition by professional organizations is also highly valued, and, in the medical profession, is the most important criterion in the selection of continuing education activities.[14] Consequently, allowing more blended learning courses to count for continuing education units may serve to further increase the demand for this type of instructional model.

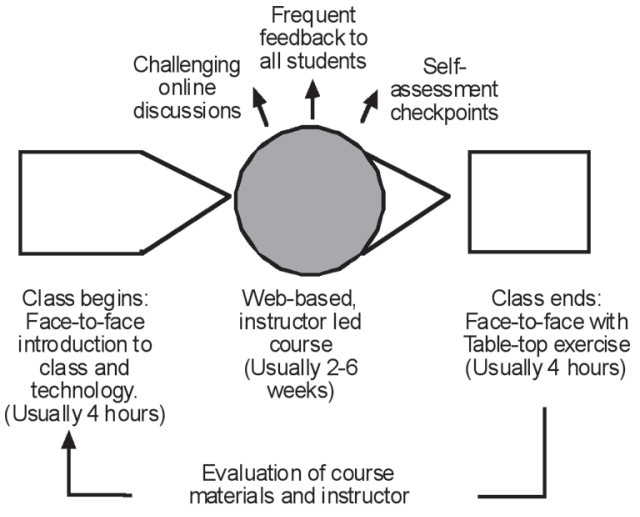
BLENDED LEARNING IN PRACTICE, EXAMPLES OF COURSEWORK

To our knowledge, the lead author of this paper (Dr. Moore) was among the first to introduce the blended learning approach for training public health workers. He worked in collaboration with administrators of the Rhode Island Department of Public Health including William Waters, Deputy Director, Donna Costantino, Human Resource Coordinator, and Christine Goulette, Training Officer, using both surveys and focus groups to develop the blended approach for public health workers. Dr. Moore first introduced five blended emergency preparedness courses (from September 2002 through September 2004) to over 120 staff and management. Dr. Moore is currently using a similar process in collaboration with the Connecticut Department of Public Health (CDPH). Through his affiliation with Yale University and under the auspices of the Connecticut Partnership for Workforce Development, he has worked with the CDPH since 2003 to create three emergency preparedness and two basic epidemiology courses using a blended approach.

Some general comments may be made from objective evaluations of many of these courses. This was the first online course experience for more than 80% of the participants. More than 705 of the participants participated in the onsite and online portions of the courses during normal paid working hours. Seventy-five percent of the participants preferred the combination of onsite and online learning to other alternatives, including two-way videoconferencing, audiotapes, webcasts, CD-ROM, self-study, satellite broadcasts, and tabletop exercises. Eighty percent or more of the participants believed that the objectives of the courses were met to a moderate or high degree, found that the training materials were useful and provided them with new information, and would recommend the training program to others.

This approach and use of best practices is identical to that described by Margie Martyn for liberal arts college curricula presented in Cleveland, Ohio in 2003.[15] There is initially a face-to-face meeting that familiarizes the students with the technology, introduces the expectations of the course, presents an introductory chapter, and helps to create a sense of community through introductions (Figure). The technology components that are introduced include an opportunity for each student to log on to the online course and navigate through the course under direction. The students also test the interactive components of the course including e-mail and threaded discussions with postings and responses. This interactive feature is used throughout the course for each unit or chapter covered. Additionally, frequent feedback and assessment is used to motivate students throughout the course, including comments on all submitted threaded discussions within 24 hours for each student, responses to the class via email, and electronic cards that are used to praise student efforts. A final face-to-face class is mandatory and consists of a tabletop exercise that involves all students in a scenario that is a culminating experience of all the principles they have learned during the course.

Figure. The Blended Learning Process



EFFICACY OF BLENDED LEARNING

Although blended learning strategies are gaining in approval and popularity, rigorous evaluation is needed to ascertain whether these methods are valid in providing measurable improvements in job performance or response in comparison to other techniques. To answer this question, the learning company Thomson NETg conducted the multi-year "Thomson Job Impact Study."[6] Thomson designed a study with the following five groups: three groups exposed to blended learning solutions, a fourth E-learning group that received strictly online training, and a control group that received no training. Each participant in the study completed a post-assessment and three real-world tasks after they received the training. Researchers found the following results:

- The three blended learning groups performed nearly the same on the real-world tasks, with an accuracy ranging from 153% to 163% better than the control group and between 27% and 32% better than the e-Learning group.
- The three blended learning groups performed real-world tasks between 41% and 51% faster than those who received e-Learning alone.
- The participants in the e-Learning group performed tasks with 99% more accuracy than the control group.

The Thomson Study identified three core features that contributed to the success of the blended learning approach:

- Use of Scenario-Based Exercises as the basis for learning software,
- Use of full-featured, actual software, and
- Assessments designed to parallel real-world tasks.

Similarly, student and faculty satisfaction and student learning outcomes have been consistently higher with blended learning courses taught at the University of Central Florida than with comparable face-to-face and fully online courses.[3] Researchers at UCF conclude that blended learning addresses such challenges as access, cost, efficiency, timeliness of degree completion,

and lifelong learning issues. The UCF study found that blended courses have the potential to increase student learning outcomes while lowering attrition rates when compared with equivalent fully online courses, and that the blended model is comparable or better than face-to-face courses in this regard. The researchers concluded that the rhythms of blended courses differed from those in face-to-face classes, and required students to interact on a regular basis and remain actively engaged. Although substantially changing the way they learned, this model allowed students to retain the familiarity of face-to-face class meetings.

One of the contributing features to the success of blended learning in increasing learning and retention may be the sense of community among students. Roval and Jordan tested the hypothesis that the sense of community would be strongest in the blended course when compared to traditional and fully online courses.[7] The Classroom Community Scale was used to measure connectedness and learning from an instrument containing 20 self-report items featuring a five-point Likert scale. Various statistical measures such as analysis of covariance (MANCOVA) and the Beta squared (h2) statistic were used to analyze the data. The blended course possessed the highest estimated marginal mean of the connectedness variable, followed by the traditional courses and then the online courses. The evidence supports the conclusion that blended courses produce a stronger sense of community among students than either traditional or fully online courses.

GAPS IN CURRENT RESEARCH IN USE OF BLENDED LEARNING IN PUBLIC HEALTH PREPAREDNESS

A search for studies on the effectiveness of blended learning in providing measurable improvements in job performance for the public health workforce in emergency preparedness found no results. Nothing similar to the Thomson Study, performed on corporate entities, could be located for public health.

To begin, our research team searched for articles published through January 2005 using the following electronic databases: PubMed, ERIC (EBSCOhost), and Education Abstracts. An internet search was also conducted using the Google search engine. Search terms included "*effectiveness, success, distance learning, blended learning, public health, emergency, and preparedness.*" As part of the internet search, our team also followed up by following links and visiting websites not identified simply through using the terms in the Google search.

Our search produced five studies on the use of distance or blended learning in public health: one study on the effectiveness of blended learning and user satisfaction, one study on user satisfaction with blended learning, and two studies on user satisfaction with distance learning.[9,16–17] A study by Davis, et al. on effectiveness and satisfaction consisted of participants in the University of North Carolina Chapel Hill's (UNC) Master of Public Health blended education program filling out a post-program survey that evaluated the course's impact on their skills and their personal satisfaction with the course.[9] All measurements were self-reported. Impact measurements included participants' opinions as to if the program impacted their ability to do their current job, improved key skills, and changed their perspective on public health. Additional measurements included data on job changes, promotions, and new affiliations and service commitments since program completion. The investigators found the program to be successful in both satisfaction and impact, but did note that the purpose of the study, which lacked a control group and impartial observers, was not intended to confirm the validity of distance learning as a format for graduate education.

A study measuring solely the satisfaction of blended learners was also based on the UNC program.[21] While specific aspects of the program received low scores by students, such as satisfaction with feedback from instructors, participants were satisfied overall. Hannon et al. examined just the distance learning component of the UNC study and found similar results, e.g., overall satisfaction with the program by participants, albeit with areas for improvement.[22]

The final two studies evaluated student satisfaction with newly established flexible learning courses in Korea.[23,24] One study evaluated user satisfaction with two courses, Systems Analysis and Case-Control Study, while the second Korean study evaluated a vaccine education program for public health officials. Researchers in the first Korean study evaluated both the appropriateness of course content and the appropriateness of system characteristics for each course through self-reported data by students. Overall, 66.7% of the participants in both classes felt the online courses satisfactorily met the course objectives.[23] Results were mixed as to student satisfaction with the vaccine course. Of the respondents, 55.3% reported the online course to be less effective than traditional off-line learning, while 89.7% of participants would take part in future web-based learning.[24]

Despite the initial data that shows distance learning and blended learning to be promising instructional methodologies for preparedness training of public health workers, research gaps exist in the evaluation of these techniques. The rapidly developing technol-

ogy of this field makes some of these studies outdated. The limited number of studies and the small sample sizes of the studies do not cover a wide cross-section of available technologies. Also, the use of satisfaction data by the investigators does not adequately measure the efficacy of distance learning in either preparedness or public health training. Finally, it should be restated that distance learning is distinct from blended learning, and while results of distance learning evaluations may serve as useful indicators as to the probable efficacy and user acceptance of blended learning, distance learning data does not serve as an adequate replacement for specific blended learning studies.

MOVING FORWARD

Although very promising, the use of blended learning to advance preparedness training of the public health workforce is in need of more definitive studies that measure improvements in response and job performance. Blended learning, specifically in the field of preparedness, should be evaluated further, and program designers can help achieve this aim by building data collection tools into software programs' initial designs. Once data is evaluated, it can be seen if the benefits of blended learning found in other fields carry over into preparedness training. This information can be used to guide policy makers and educators as they plan national, regional, state, and local trainings for the public health workforce.

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