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STRENGTHENING HAZARD VULNERABILITY ANALYSIS: RESULTS OF RECENT RESEARCH IN MAINE

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Since the events of September 11, 2001 (9/11), health-care institutions have been encouraged to enhance their readiness for disasters. The Joint Commission (previously the Joint Commission on Accreditation of Healthcare Organizations) has, since 2001, required member hospitals to complete an annual hazard vulnerability analysis (HVA), which is expected to provide a foundation for emergency planning efforts. A literature search revealed that little has been written and published on HVA since that requirement came into effect, and no known investigation of current HVA procedures has been completed.

To begin to address this gap, researchers from the Harvard School of Public Health and the Southern Maine Regional Resource Center for Public Health Emergency Preparedness (SMRRC) interviewed staff members at eight hospitals in Maine to document current HVA processes and develop recommendations for improvement. SMRRC is one of three regional nonprofit hospital-based centers in Maine guiding health systems and public health preparedness activities.

BACKGROUND AND OBJECTIVES

Hospitals and other health-care organizations have always had to prepare for and respond to a wide array of routine emergency and catastrophic disaster events. Since the terrorist attacks of 9/11 and subsequent attention and funding from the U.S. Department of Health and Human Services and Department of Homeland Security, hospitals have been urged to substantially expand their response plans and overall readiness for disasters. Hospitals are now expected to develop, implement, train, and exercise comprehensive all-hazards emergency management and operations plans. These planning efforts need to be inclusive of all four phases of emergency management: mitigation, preparedness, response, and recovery.

Emergency management programs and their associated emergency operations plans are only as good as the assumptions upon which they are based, which is especially true at the local level where planning must take into account specific risks unique to the immediate environment. Local priorities need to be considered, in addition to those required by federal and state authorities, and detailed in the goals, objectives, and deliverables tied to all funding streams. However, local priorities based on opinion alone, and not on objective data, can provide a weak foundation for planning. Expert clinical or administrative staff opinions can result in waste, duplication, missed opportunities, siloing, and confusion over what the true priorities are in terms of threat, vulnerability, and risk.

In the 2001 edition of its *Comprehensive Accreditation Manual for Hospitals,* the Joint Commission significantly revised the existing standard for emergency management.[1] For the first time, the Joint Commission was guiding hospital emergency preparedness efforts "into the same arena as emergency management in the community as a whole."[2] Hospitals were now expected to function as an "integrated entity within the scope of the broader community."

The 2001 standard urged that hospital response plans now must be "based on a hazard vulnerability analysis (HVA) performed by the hospital." Although HVA was a relatively new term for hospital staff, the concept itself was not.[2] The Joint Commission defined HVA as "the identification of hazards and the direct and indirect effects these hazards may have on the hospital." The actual or anticipated hazards are analyzed in the context of the population at risk to determine the vulnerability to each specific hazard.

Hospital emergency managers have long performed HVAs in their heads, as "much of the process is highly

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intuitive." For example, hospitals in the Midwest do not need to plan for hurricanes, while those along the Atlantic Coast must. Even the way risk has been defined both qualitatively and quantitatively for hospitals is wide-ranging in its scope and use. As a result, "risk may be one of the most elusive concepts in health emergency management."[3]

While mandating that hospitals perform HVA, the 2001 Joint Commission standard did not formalize the process for doing so. Additionally, the Joint Commission did not offer a specific tool to normalize the process in hospitals. While the American Society for Healthcare Engineering (ASHE) of the American Hospital Association offered the first standard methodology in 2001 for performing a hospital HVA,[2] a wide array of other tools and methods also became available for hospitals to utilize for risk and vulnerability assessment.[3]

Later in 2001, Kaiser Permanente developed a modified Hazard Vulnerability and Assessment Tool for Medical Center Hazard and Vulnerability Analysis.[4] This tool expanded both the guidance and scope of hazard "events" that hospitals should consider. Specifically, it expanded the risk measures to include human impact, property impact, and business impact. Each measure was rated separately for each event and weighted in the final vulnerability score. Likewise, the mitigation measure was expanded from the ASHE tool, which simply rated preparedness as "poor," "fair," or "good." The new tool broke mitigation down into preparedness (preplanning), internal response (time, effectiveness, and resources), and external response (community/mutual aid staff and supplies). This final measure reflected the intended outcome of the new Joint Commission standard by assessing hospitals as community organizations rather than stand-alone institutions.

The following year, HCPro, Inc., a private healthcare regulation and compliance product and service provider, published its own HVA Toolkit for hospitals.[5] Similar to the Kaiser tool, this toolkit is meant to facilitate the evaluation of every potential event in each of the three categories: probability, risk, and preparedness. Like the others, the kit allows the user to add events as necessary. To determine probability, users are encouraged to consider known risk, historical data, and manufacturer/vendor statistics. The Joint Commission does not provide this level of detail or guidance; rather, it is individual private publishers that offer HVA tools with this level of specificity. While helpful, these modifications make it difficult to draw comparisons among hospitals, or across jurisdictions or states.

While the Joint Commission continues to refine and expand emergency management standards, it has yet to provide a standardized method or tool for conducting HVAs. What none of these tools or the Joint Commission standard offers, however, is a standardized method for collecting or using HVA data at the hospital or community level. Hospitals are left on their own to determine how they will collect information on probability and severity, how they will process that information within the institution, and what to do with the results.

The primary objective of this study was to investigate how institutions at the local level, in particular hospitals in Maine, currently implement HVA, in an effort to encourage future research on this topic to ultimately improve HVA efficacy.

METHODS

During 2005 and 2007, the SMRRC invited eight hospitals in the Southern Maine region to participate in a regional HVA process. The Southern Maine region includes acute care and mental health hospitals within York, Cumberland, Sagadahoc, and Lincoln counties, most of which are Joint Commission accredited. An electronic copy of the Medical Center HVA template and instructions were provided to each hospital's emergency preparedness contact. These individuals participate regularly in SMRRC activities and preparedness efforts. They represent a variety of departments from their institutions, including hospital administration, planning, safety, infection control, and facilities management.

Administration of the HVA tool was customized to best meet the needs and available resources of each facility. If a facility had recently completed an HVA, its staff members were encouraged to use those data to aid in the completion of the SMRRC version. Other facilities distributed the HVA forms to individual members of their internal Environment of Care or Emergency Preparedness Committees and then convened as a group to reach consensus for the organization. The HVA tool used in this study was based on the model developed by Kaiser Permanente and modified for use by the SMRRC.

During April 2008, we conducted a series of face-to-face, semi-structured, in-depth interviews with staff from each of the participating hospitals who were identified to have a key role in the HVA process at their facility. Two interviewers attended each discussion and subsequently compared notes to assure objectivity. The questions were largely drawn from a paper entitled, "Risk and Risk Assessment in Health Emergency Management."[3] Beyond the issues suggested by this paper, the interviewers discussed the HVA results

produced in each hospital and changes in results from year to year.

RESULTS

The lack of standardization in the HVA process from hospital to hospital became apparent as the survey progressed. Specifically, the researchers found the following:

1. The scope of risk varied a great deal across the institutions. Some hospital staff considered the scope to be limited to the institution's campus, while others had an expanded view and considered risks to the hospital's entire service area.
2. The planning time frame was rarely clarified and often varied from institution to institution. In some hospitals, staff believed that they were planning for one year, while in other hospitals they believed that they were planning for a longer time frame (e.g., three to five years).
3. The individuals facilitating the process had a large impact on the results. For example, regarding scope of risk, staff members with hospital engineering backgrounds focused on the institution, while others with public health exposure and training tended to focus on the community. An individual's personal experience with disasters had a substantial impact on the results. Changes in HVA results from period to period tended to be those hospitals with substantial changes in the staff responsible for HVA.
4. The level of resources committed to HVA differed greatly. None of the institutions prepared a budget specifically targeting this activity. The number of hospital staff substantially involved in the deliberations varied from one person to 20 people, and the difference was not consistently related to the size of the institution. In addition, while some hospitals invited community experts (e.g., fire, emergency medical services, police, and emergency management personnel) into the process, most limited participation to their employees. Only one hospital staff member used information available at the county emergency management agency office, despite the availability of that staff and knowledge base to all participants.
5. The decision-making process was usually informal. The process of arriving at decisions was rarely made explicit. No minutes were kept in any of the institutions to record, for example, differences of opinion regarding risk, although many of the individuals interviewed could recall differences, including animated debates.
6. Changes in results were apparently highly associated with whether the process was framed and managed as incremental or not. In some hospitals, the results from prior years were present for discussion of the current year's risks. In others, the issue was considered without reference to previous results.
7. The results of the HVA process were not widely shared. Hospital staff rarely communicated results outside the institution beyond the Regional Resource Center that requested them. Within the institution, the results were nearly all communicated to established (e.g., safety) committees, but only a few hospitals channeled results to the Chief Executive Officer (CEO) and Board of Trustees for discussion.
8. HVA results affected preparedness activities very differently from institution to institution. In one hospital, the results were only communicated to the external Regional Resource Center, and never passed on internally. That hospital's staff members believed that the Regional Resource Center needed the information for regional planning purposes and did not understand that the HVA was completed primarily for internal planning and accreditation purposes. In contrast, at another hospital, staff members completed an annual action plan detailing how they were going to respond to each of the risks identified.
9. The commitment of individual hospital senior leaders, including the CEO, had a substantial impact on the HVA process, influencing both the level of resources committed and the management of results.

CONCLUSIONS AND RECOMMENDATIONS

We believe the efforts presented in this article are among the first exploratory investigations into this important issue. We encourage other public health professionals to pursue investigations covering more health-care institutions and employing more rigorous research methods. In addition, we offer the following recommendations:

1. The HVA process should be developed to achieve a greater degree of standardization. For example, the scope of risk and planning time frames should be clarified and applied

consistently across hospitals. Guidelines should also encourage greater use of other community experts and available information.

2. The level and types of expertise required should be addressed. The HVA was added to the Joint Commission requirements because the importance of emergency planning has been enhanced. Enhanced quality of planning also requires input from diverse areas, including facility management, public health, emergency management, administration, nursing, and medical care.
3. The Joint Commission should address the issue of periodicity. Currently, hospitals are expected to complete an HVA on an annual basis. We believe that the process should be changed from annual to every other or every third year unless a serious alteration in conditions occurs (e.g., construction of a nuclear power plant nearby). Too-frequent assessments tend to dull the process and reduce it to an insubstantial incremental procedure with little impact.
4. Each hospital should be encouraged to pursue the following steps when completing the HVA:
   - Research into vulnerability through public safety, emergency management agencies, and other sources of information;
   - Organizational meeting of individuals to be involved in the deliberative process that would clarify the decision-making process as well as its importance within and outside the institution;
   - Individual completion of the assessment instrument in private to encourage differing opinions;
   - Group discussion and consensus;
   - Documentation of discussion, including minority opinions and overall results;
   - Documentation of action planning to address identified gaps; and
   - Wide distribution of the results both outside and within the institution, including to the most senior decision makers.

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On Academics

ALIGNING A DEPARTMENTAL DrPH PROGRAM WITH THE NEW ASPH COMPETENCIES

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In 2007, the Association of Schools of Public Health (ASPH) Education Committee initiated a project to develop a model of core competencies to be used as a resource and guide for academicians interested in developing and improving doctor of public health (DrPH) programs and curricula at their institutions. The model includes a set of 54 competencies across seven domains that, ideally, all DrPH graduates should be able to perform. These domains include advocacy, communication, community and cultural orientation, critical analysis, leadership, management, and professionalism and ethics. The model highlights the importance of developing leadership skills among DrPH students to prepare them to assume senior-level public health research and practice positions.[1]

The centrality of the model's concept of leadership emanates from the definition of the DrPH degree adopted by the ASPH Education Committee. The committee used the definition from the Institute of Medicine (IOM) report, "Who Will Keep the Public Healthy? Educating Health Professionals for the 21st Century:" "The basic public health degree is the master of public health (MPH), while the doctor of public health (DrPH) is offered for advanced training in public health leadership."[2] The ASPH Education Committee drew a distinction between the purpose of the DrPH degree *vis-à-vis* the doctor of philosophy (PhD) degree in public health education programs. Committee members noted that both of these doctoral degree programs "should prepare graduates for research careers, with PhD training typically aimed at graduates who focus their research in narrowly defined areas, while the DrPH is . . . an advanced professional degree designed to prepare individuals for public health evidenced-based leadership and practice-based research roles."[1]

The Department of Behavioral & Community Health Sciences (BCHS) at the University of Pittsburgh Graduate School of Public Health (GSPH) has had a departmentally based DrPH program for many years. In the past several years, there has also been an increasing demand for a PhD program. As a result of a change in BCHS leadership in 2007 and the development of a strategic plan for the department, work began in 2008 on restructuring the doctoral program. The restructuring involved simultaneously creating a PhD in the Social and Behavioral Sciences and making major modifications to the existing DrPH degree in keeping with the emerging ASPH competencies.

Our two doctoral degrees focus on training individuals to be able to work in a complementary fashion along the prevention intervention continuum. PhD students focus on developing the skills to work in academic settings and design and test new, theory-driven social and behavioral interventions in randomized, controlled trials to determine their efficacy. DrPH students concentrate on learning how to translate, implement, and evaluate existing evidence-based programs into real-world, practice-based settings. The curricula for the two degrees are designed so that students in both programs take a common set of critical analysis courses in theory, methods, and statistics. This was done intentionally to facilitate a dialogue between those who will be leaders in practice-based research and those whose future jobs will entail the design and testing of prevention interventions in academic settings. Hopefully, this interaction will create a strong foundation for real-world collaboration between researchers and public health professionals, thus improving the processes of program development, translation and implementation, and evaluation.

This article discusses the process of aligning our departmental DrPH program with the new ASPH competencies, the challenges encountered, and our expectations for professionals trained in our program.

METHODS

To meet the demand for high-level public health leaders, we made four key structural changes to our revised DrPH degree. First, we require an MPH degree for admission, thus satisfying the required core curriculum for a public health professional degree and ensuring mastery of the public health core. We recognize that there are substantial differences among schools of public health and, in fact, are counting on those differences to increase diversity within our department and enrich our students. However, because the core curriculum has been standardized in accredited schools of public health, requiring an MPH for our doctoral students ensures knowledge of public health in the

broad areas of biostatistics, public health biology, environmental and occupational health, epidemiology, health policy and management, and social and behavioral sciences.

Second, during our DrPH admission process, we look for individuals with a demonstrated potential for leadership and professionalism, as evidenced by an applicant's prior work experience, research conducted, publications, and other professional activities. Many of those admitted to the program have strong track records working and/or volunteering in the area of social justice, which is integral to today's public health practice. We accept students into our DrPH program who approach public health from this perspective and who are prepared to learn theory, methods, and systems thinking to expand the reach and breadth of their work in the field. We recognize that some applicants are currently employed in positions of responsibility that they do not want to leave. As such, we offer these individuals the option of attending the program part-time.

A third substantial change to the DrPH program is the incorporation of courses from other departments within the school, specifically the Department of Health Policy and Management (HPM), to complement the existing BCHS doctoral coursework. Although we were committed to adding course requirements specific to the advanced study of advocacy, management, ethics, organizational theory, and professionalism, it was not feasible to increase the demands on our faculty members by having them develop and teach new courses in these content areas. Our concern was that doing so would sacrifice the quality of existing courses by drawing time and attention away from them. Incorporating courses from other departments is a much more cost-effective and cost-efficient approach and enables our students to access doctoral-level classes that build upon their MPH training.

Finally, we created an Executive Management Practicum that provides students with an opportunity to exercise the skills that they have learned in the classroom setting by applying them in supervised practice settings. The Figure shows the structure of the BCHS DrPH program.

THE NEW DrPH PROGRAM

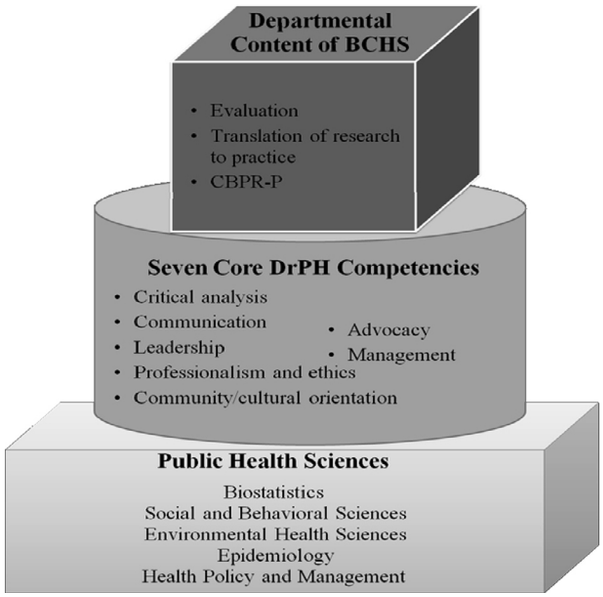
Incorporating the competencies into the curriculum

Although our revised DrPH program is aligned with the ASPH competencies, there is more in-depth coursework in two of the competency areas—critical analysis and community/cultural orientation—than in other areas. The focus on these two competencies is a reflection of our faculty orientation and expertise, as well as the need to develop a solid grounding in theory and analytical methods for a doctoral degree. Seven courses fall into the critical analysis domain, including two evaluation courses that provide a foundation for our graduates to conduct evaluation research on the effectiveness of evidence-based programs in organizations that they will lead.

Our DrPH students will also be engaged in conducting evaluation research under the direction of faculty in the Institute for Evaluation Science in Community Health, which is housed in BCHS and led by two of our senior faculty members. Students will have opportunities to be involved in practical applied evaluation initiatives at the community level. In addition, DrPH students may elect to complete the Evaluation Certificate Program, which provides them with additional training in the application of both quantitative and qualitative methods for evaluation.

A second competency area that is a focus of BCHS coursework is community/cultural orientation, which includes three courses. The sequence of courses in this area is critical to our students' understanding of community context and social norms that informs the processes of translation, implementation, and program evaluation. Our DrPH students will learn

Figure. The structure of the DrPH degree program in the BCHS, Graduate School of Public Health, University of Pittsburgh



DrPH = doctor of public health
BCHS = Department of Behavioral & Community Health Sciences
CBPR-P = community-based participatory research and practice

how to translate evidence-based interventions to specific settings by engaging and working with relevant communities to adapt interventions as necessary. Our department has a strong foundation in community methods, and especially in community-based participatory research and practice, and offers a certificate in this area. This foundation will enhance students' opportunities for public health leadership success post-graduation.

To address the leadership and communication competencies, BCHS has also included a leadership course and has developed a new health communication doctoral seminar to be added to the DrPH curriculum. Although these additions give only a minimal amount of attention to these topics, we expect that the required Executive Management Practicum will afford students additional opportunities to hone these skills. We incorporated four courses from HPM within GSPH to address the remainder of the competencies. These include one course in advocacy, two management courses—one each in organizational theory and public health agency management—and one course focusing on public health law and ethics.

Integrating public health research and practice

In addition to the previously described coursework, which addresses the seven ASPH competencies, we have instituted two other changes to the BCHS curriculum to integrate the realms of public health research and practice. First, we created a new course that provides formalized training in how to translate evidence-based knowledge to practice. This course provides a foundation in basic concepts, theories, practical approaches, and methods associated with prevention and will focus on behavioral and psychosocial areas, including substance abuse, mental health, victimization, and sexually transmitted infections (e.g., human immunodeficiency virus).

Second, we redesigned an existing two-semester Integrative Seminar. One semester of the doctoral seminar focuses on developing skills in grant writing. During this semester, students are required to write and submit a predoctoral fellowship or dissertation research application to demonstrate this ability. In the second semester, students focus on developing skills in writing for publication, and they work with faculty on submitting a manuscript for publication to a peer-reviewed journal.

This seminar is a requirement for both DrPH and PhD students. The BCHS faculty made a deliberate decision to include students from both programs to emphasize the interactive and complementary domains of public health research and practice, as well as to facilitate the cross-fertilization of ideas and collaboration among the doctoral students. One of the two semesters of the Integrative Research Seminar is led by our Department Chair and the other by our Vice Chair, which gives the doctoral students access to senior-level mentorship. Because these faculty have a limited amount of time, having them lead the Integrative Research Seminars is an efficient way for them to facilitate group mentorship, as well as for students to offer peer review and support to one another.

Finally, the Executive Management Practicum is another way we integrate the realms of public health research and practice. The Practicum includes three semesters of intensive, high-level work with public health agencies. We have established relationships with local, regional, and national health organizations that can provide our students with opportunities to apply the various skills learned *vis-a-vis* the ASPH competencies. These agencies include, for example, the Allegheny County Health Department, where students will focus on applying their strategic management and leadership and communication skills, and the Susan G. Komen for the Cure organization, where students will be able to apply leadership, communications, and advocacy skills.

Milestones

Our DrPH program incorporates four milestones that must be achieved during the course of study. The milestones are incremental in that each can be achieved only after successful completion of the preceding milestones. The first milestone is the Preliminary Examination, which is an assessment of the breadth of the student's knowledge of the discipline, the student's achievement during the first year of graduate study, and the potential to apply research methods independently. This exam is typically taken after the first two full semesters of study, and after the student has successfully completed 24 required credits in the program.

The second milestone is the Comprehensive Examination, the purpose of which is to assess the student's mastery of the general field of doctoral study, the student's acquisition of both depth and breadth in the area of specialization within the general field, and the ability to use the research methods of the discipline. The Comprehensive Exam is typically taken after four semesters of full-time study or the equivalent number of hours for part-time students.

The third milestone is the Dissertation Overview, which requires the student to formulate a dissertation plan and permits the doctoral committee members to provide guidance in the conceptualization and

methods to be used. The final milestone is the Dissertation Defense, which must take place a minimum of eight months after the Comprehensive Exam.

DISCUSSION

The modified DrPH program in BCHS was approved by the University of Pittsburgh in January 2010. We just admitted our first students to the new program in fall 2010. During the admissions process, we carefully reviewed each applicant's credentials and discussed their goals with them during the required interview to determine if there was a good match between their interests and our program. We believe that we have accepted a group of individuals with demonstrated leadership potential who have an interest in the translation of evidence-based programs into practice. For example, one new student discussed her career interests as follows:

> I want to be a technical expert and leader in the field of behavior change communication and community mobilization . . . I need to strengthen my analytical and qualitative research skills so that I can contribute to [addressing] the unanswered questions [in the field] . . . . I would like to find a balance between my research, program implementation, and teaching activities. After completing my dissertation, I would like to give back to the university as an adjunct professor, and utilize a feedback loop between academia and the field setting. This will allow for constant process improvement of interventions in a field setting, while applying rigorous evaluation methodologies, and bringing real-time improvements in the classroom. Lastly, I want to devote my life to what I am most passionate about: human and community development and empowerment through improved health [disease] prevention and [health] promotion (Personal communication, Kamden Hoffmann, BCHS Doctoral Student, June 2009).

This career goal statement from one of our new DrPH students reflects the type of professional interests of our new students. Although our recent DrPH graduates were not enrolled in the same program, they are currently employed in a variety of practice settings, although a few have chosen academic careers. For example, a few of our recent graduates are completing postdoctoral fellowships, but the majority are engaged in practice settings, including public health research analysts, program evaluation analysts, and program directors at both public organizations (e.g., local and state health departments and federal agencies such as the Human Resources and Services Administration and the Centers for Disease Control and Prevention) and private organizations (e.g., nongovernmental organizations, nonprofit research institutes, and health insurance providers). It is our expectation that our DrPH students will increasingly become involved in high-level practice settings and public health leadership roles.

Students who enroll in our revised DrPH degree program can expect to receive training that reflects the current thinking in public health academic circles about the necessary skills that students in DrPH programs need to master. The revised BCHS DrPH program not only incorporates the ASPH competencies, but also reflects the thinking embodied in the IOM recommendations regarding doctoral education—that is, to prepare individuals for senior leadership positions in public health research and practice; to prepare students to be able to approach public health problems from an ecological, population-based perspective; and to provide supervised practice opportunities in a variety of settings.[2] In addition, the value of our departmentally based rather than school-wide DrPH program is that it strengthens the emphasis on social and behavioral sciences while still allowing for interdepartmental collaboration. The public health professionals who graduate from our DrPH program will be trained to draw on the theory and methods from the social and behavioral sciences to translate/adapt, implement, and evaluate evidence-based health promotion interventions.

The extent to which we are successful in our training efforts needs to be evaluated. We plan to monitor our progress via a set of measurable learning outcomes that we are required to submit to the Provost's Office at the University of Pittsburgh. Our outcomes include the number of students who are publishing their work and student progress through the program, as measured by milestones achieved.

CONCLUSIONS

The DrPH students we are currently interviewing as part of the admissions process are very clear about their interest in becoming public health practice leaders and have demonstrated the potential for success in this area. The modified DrPH program in BCHS at the University of Pittsburgh's GSPH is aligned with the seven competency areas outlined by ASPH, and the program presents a range of opportunities for learning, experience, and collaboration. Collectively, these opportunities will facilitate the development of skills that graduates of our program will need to be the next generation of leaders in today's public health environment.

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Student Column

THE BENEFITS OF USING GEOGRAPHIC INFORMATION SYSTEMS AS A COMMUNITY ASSESSMENT TOOL

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Community assessment—a gathering of information about a given community—is critical to understanding health issues at the grassroots level. Community assessment through data collection is an integral component of community health programming. Without proper assessment of a community's needs and assets, public health professionals are uninformed, underprepared, and may develop health programs that are potentially ineffective and irrelevant.[1] Various tools are used to gather community data, from ethnographic observations to key informant interviews and surveys. While these tools remain an integral part of the public health toolbox, the information provided by such tools is not easily interpreted by the general public. Furthermore, such data often fail to reveal the direct correlation between geographic location and health.

More than 100 years ago, John Snow used maps to discover the source of the London cholera outbreak.[2] Snow took what he knew of the health of individuals in the community and created outbreak maps, connecting the information to the individuals' geographic location, and eventually discovering the source of the epidemic. The modern application of Snow's methods, geographic information systems (GISs), is an existing tool applied to highlight community assets and display spatial patterns in a way that was not previously possible.[3] GISs have been well documented as a tool that can collect, organize, retrieve, analyze, and display public health data in relation to place.[4] (To better understand GIS capacity, consider global positioning satellite [GPS] devices in cars that use satellites to depict a given geographic location using X and Y coordinates.)

Maps produced from GIS data can be used to depict relationships and significant hotspots within a community. For example, researchers used GIS to determine if there was a relationship between environmental conditions and high-risk sexual behavior. They developed a "broken windows" index that referred to the level of deterioration of the surrounding environment. Through the use of census data and the collection of GIS coordinates, the researchers were able to reveal a significant association between deteriorated neighborhoods and rates of gonorrhea.[5]

Rather less documented, however, is the fact that GIS maps can be more user-friendly than other forms of data presentation, helping community-based organizations (CBOs) understand community data and facilitating a better understanding of the community. The result should be programs that can better address community needs.[3]

This article illustrates a case study of the application of GIS in a community assessment school project, showing the usefulness of GIS in mapping community needs and assets and in communicating the results to the community and its partners.

THE ADVANTAGES OF USING GIS

Studies have shown the effectiveness of using GIS software. For example, McLafferty and Grady studied the geographic distribution of women's health services provided by urban, community-based free clinics. GIS data revealed substantial gaps in health-care access among various racial/ethnic groups. Once the information was shared, community clinics reallocated their resources to reach more of the surrounding population.[6]

When CBOs operating in underresourced communities are given access to user-friendly data, they are better able to use the information to make evidence-based decisions for program planning. Aronson et al. tested

this concept in a community assessment addressing infant mortality, using GIS mapping to gather data and engage residents in the health initiative. GIS mapping enabled the researchers to produce more accessible and understandable information for the residents.[3]

Choi et al. used GIS to identify environmental health risks in a Baltimore community. The researchers then surveyed patients at a nonprofit community clinic. Linking the survey information to GIS data, community stakeholders uncovered relationships between geographical location and environmental exposure. The researchers concluded that GIS mapping makes health information more accessible and easier for community stakeholders to interpret.[7] Because public health programming hinges on information, the graphic depiction of data is invaluable, as it links health information to its geographical location. As a result, communities find new solutions to address public health problems.[8]

THE STUDENT ROLE

In fulfillment of a class assignment, public health graduate students at Loma Linda University decided to test the benefits of using GIS in community health projects and improve their GIS skills by conducting a case study in partnership with a CBO located in the Westside community of San Bernardino, California. Westside is an area of approximately four and a half square miles. Historically African American, the community's demographic has transitioned so that more than 70% of its population now claims Hispanic race/ethnicity.[9] The university made arrangements to allow students to collaborate with the CBO to improve community programming.

When initially approached about working with the students, the CBO expressed reluctance to participate, as it was frustrated over not having access to the results of past assessments, rendering them unable to use the findings to improve community health programs (Personal communication, CBO Executive Director, October 2007). Instead, they relied on publicly available data, such as census data. Though hesitant, the CBO leadership agreed to collaborate with the public health students with the understanding that the students would provide copies of all the assessment data to the CBO upon completion of the project.

The students' first task was to perform comprehensive needs and assets-based assessments of both the Westside community and the CBO. When assessing the CBO, the students learned that its mission is broad and all-encompassing, but that it emphasizes providing social, spiritual, and physical support to the community, particularly young people.

The CBO and surrounding community have been the focal point of several assessments in the past due to their close proximity to multiple universities that wanted to collect data. Prior assessments never used GIS; rather, approaches to data collection were limited to subjective, qualitative methods involving surveys and key informant interviews. Although useful, these methods lacked the vivid and comprehensive assessment of a community's physicality that GIS provides.

An initial asset inventory revealed that the CBO had developed a number of programs—ranging from parenting and nutrition classes to life-skills training and activities for young people—that could benefit from GIS data. For example, a GIS map displaying the relative locations of supermarkets in the community could aid program planners in preparing for their nutrition classes. When conducting food demonstrations in supermarkets, CBO staff could view these data beforehand and make better decisions about which markets to visit depending on the residence of their program's attendees.

METHODS

Data collection

The GIS data collection was part of the community assessment; the goal was to highlight assets and needs that existed within the Westside community. However, to do this successfully, the students had to first perform a qualitative assessment of the CBO, the community residents, and the physical aspects of the community itself. Through the use of windshield surveys, key informant interviews, and ethnography, the students were able to identify areas of concern. This information guided the students as they collected the GIS data. While they recorded data points for each establishment and advertisement they observed in the community, the qualitative assessment information alerted them to specific areas.

In the past, data collection for community assessments was usually the result of the aforementioned methods and, thus, the primary way the students collected data points was through windshield surveys. However, the use of GIS added another dimension to the process. To conduct a community asset inventory, students used Trimble® Recon GPS units (Trimble Navigation Ltd., Sunnyvale, California) loaded with customized data dictionaries to collect spatial data points. Having an idea of what types of data might be obtained, students entered different categories to create the customized data dictionaries. Each GIS data point collected was entered in the GPS units under one of the following categories: health and safety,

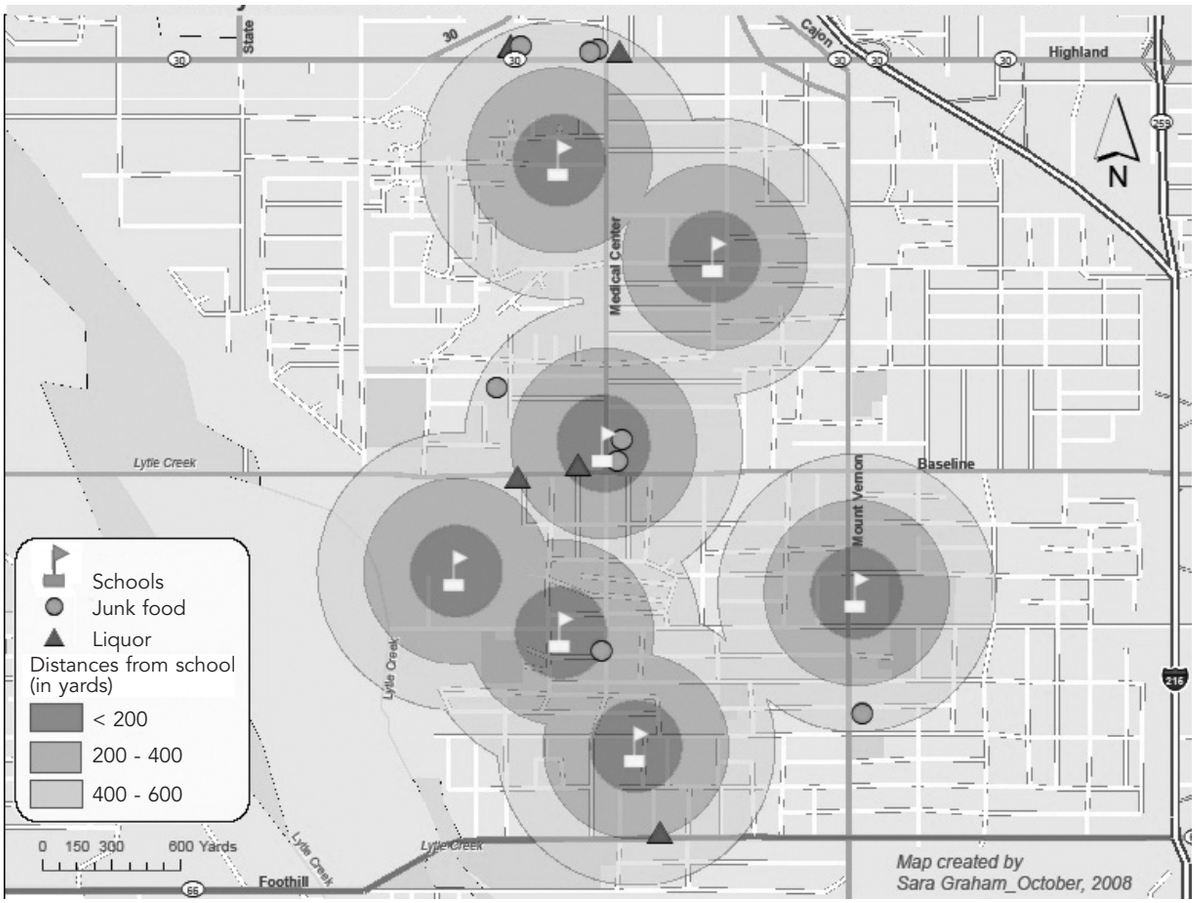
transportation and advertising, education, community asset, food security, and other. Data points included small businesses, hospitals, restaurants, transportation, and advertisements. Other data were collected for abandoned houses and environmental hazards. In addition, because of crime in this ZIP code, as reported from the San Bernardino City Police Department's official website, we collected data points for liquor stores and ammunition shops, which were perceived contributors to these reported data.[10]

Data analysis

After collecting data points, the students triangulated the data by contacting community residents and CBO staff, thereby ensuring reliability. As there was more than one team of students collecting data at any given time, all of the students compared the data post-collection to ensure that no duplicate data points were mapped and reported. Students then used Environmental Systems Research Institute ArcView® 9.2 GIS software to aggregate the data, create maps, and highlight findings.[11]

We used buffer functions to create a circumference of 600 yards around all Westside schools to determine the number of junk-food and liquor stores that fell within that area (Figure 1). Buffer functions are a feature of GIS software that allows one to create a radial area of a desired distance around specific data points to more easily identify relationships among the data with regard to distance. We initially used the base of 200 yards because that is the restriction placed on liquor stores by the state's Department of Alcoholic Beverage Control (ABC).[12] However, we expanded the distance to 600 yards because that is considered a normal walking distance for the residents of this community, and the students wanted to display the probability of a child passing such a place on their daily commute to school.

Figure 1. Unhealthy food choices around schools in the Westside neighborhood of San Bernardino, California, October 2008



We analyzed the data to highlight potential relationships that might exist with regard to the distance between unhealthy food establishments (e.g., liquor stores, convenience stores selling junk food, and fast-food restaurants) and Westside schools. Students theorized that the close proximity of these establishments to the schools was a direct contributor to health problems (e.g., obesity, diabetes, and heart disease), which, according to the CBO leadership, were known to be prevalent in the community.

RESULTS

When finished analyzing the data, the students presented the CBO leadership and staff with the results of the study, including copies of the maps created and a written report that explained the findings. By using GIS to display information gathered from the qualitative assessment, the staff were able to view this information graphically. For example, the students not only collected X and Y coordinates of a convenience store, but actually went inside and looked around, noting what goods were sold. Now a convenience store can be identified not only by its location on the map, but also by the type and quality of food and drink sold there, based on the descriptions students attached to that data point. These attributes can then be mapped and presented graphically. That is, a map can be created based on all the convenience stores that sell liquor.

In the weeks following the presentation, students interviewed the CBO staff to determine what knowledge had been acquired and how they believed the information could be applied. Staff were interviewed regarding the validity of the information displayed in the maps, their ability to interpret them, and their confidence in sharing them with other key stakeholders.

Outcomes

GIS maps created by students from the collected data revealed high numbers of what were termed by the students as junk-food establishments (i.e., fast-food restaurants and corner stores carrying predominantly unhealthy foods). Some of these establishments, including liquor stores, were within less than 200 yards of Westside schools, displaying a lack of healthy food choices for students in the community (Figure 1).

Concurrently, Figure 2 illustrates a substantial number of identified community assets, such as other CBOs and faith-based organizations. This map highlights potential partners with whom community-wide problems could be addressed.

Students also noted a high number of negative advertisements throughout the community. Advertisements for things such as bail bonds, gambling, and R-rated movies were prevalent. Certain environmental hazards were also recorded and the data shared with the stakeholders. These hazards mainly included abandoned lots tucked away within residential areas that contained harmful things such as broken glass and needles. While this dataset was not the primary focus of this research, it was brought to the CBO's attention.

Benefits for stakeholders and students

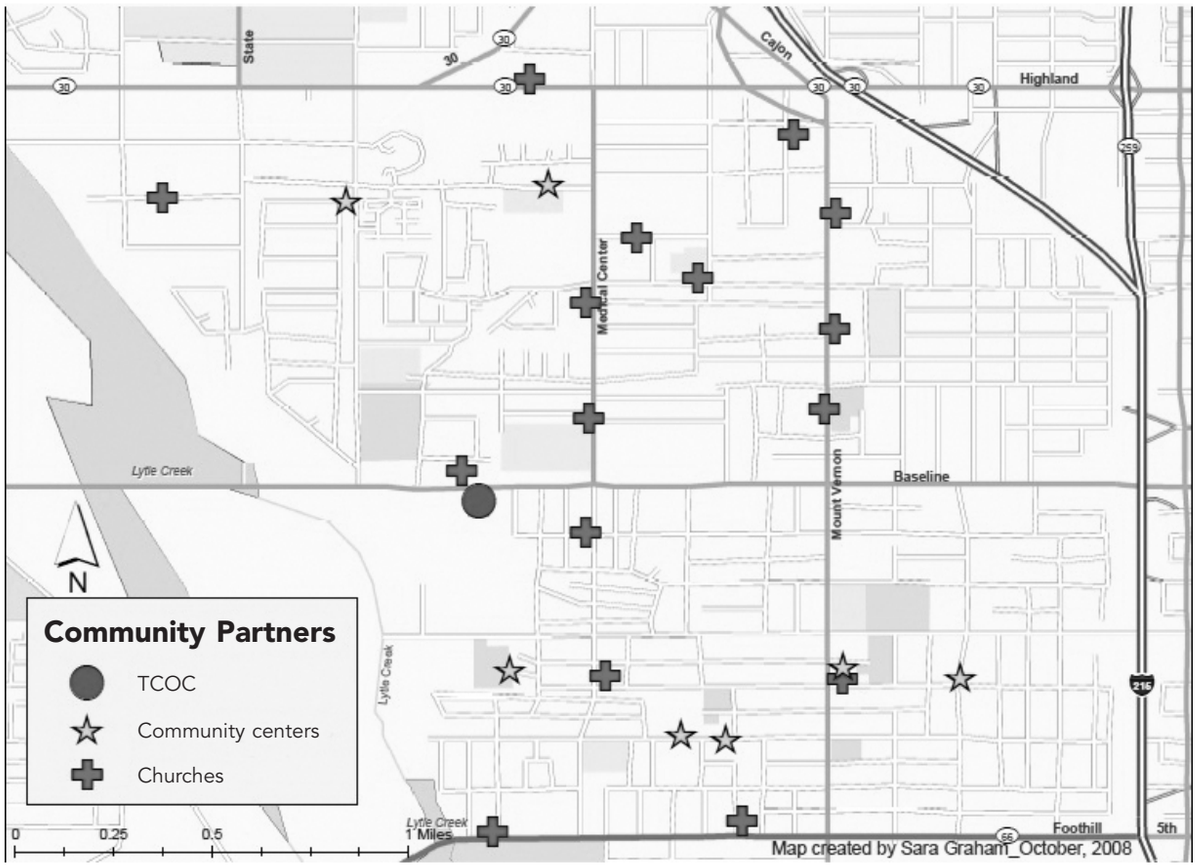
The Westside CBO was the primary beneficiary of the study. Much of the information gathered was new to the CBO leadership and staff, and they were surprised at the number of assets in their community. The maps revealed geographic details of the community that had escaped them, such as their program beneficiaries. The CBO director was pleased to discover that she had a clearer understanding of target populations and boundaries after studying the maps.

The CBO staff noticed visual correlations from the maps, including the number of liquor and convenience stores and their proximity to the community's schools. The ABC reserves the right to deny a liquor license to anyone wishing to build an establishment within 200 yards of a school, public playground, or nonprofit youth facility, especially if the proximity infringes upon the moral or peace-loving wishes of the community.[12] This regulation places the responsibility on CBOs or other community entities to act in the best interests of their community. The maps stimulated the Westside CBO to begin work on shutting down some of these establishments.

Mapping the data and sharing it with the CBO put the organization in a stronger position to advocate for the community. CBO leaders had suspected there was a problem with the community's access to healthy food, but they were not able to visualize the extent of the problem. After analyzing the maps and reports, the CBO director could clearly see the barriers that existed, including an insufficient number of adequate supermarkets, a plethora of fast-food restaurants, and numerous junk-food establishments in residential areas and school zones. The CBO director then initiated a dialogue with other community stakeholders in an effort to address the issue around Westside schools.

The students also benefited from this case study. They gained experience in community assessment—using GIS as a main data collection tool—and a basic understanding of GIS and its purpose in public health community assessments. They learned how to collect spatial data; report their findings to peers, professors, local leaders, and stakeholders; and add GIS data collection and analysis to their academic skillset. Additionally,

Figure 2. Key stakeholders in the Westside neighborhood of San Bernardino, California, October 2008



TCOC = Temple Community Outreach Center

the students left behind a rich set of community data upon which future classes could build.

Reactions and new insights

When the GIS maps were presented to the CBO, the staff were excited to receive the results of the assessment and thanked the students for fulfilling their commitment to share the findings. This exchange helped promote an additional level of confidence, strengthening the partnership between the community and the university.[13] Sharing the findings of the assessment with the CBO and the community is an essential part of community-based participatory research, a fundamental concept in public health. This type of research engages the community and its leaders, placing them in a position to make decisions based on their own data analysis. Community members can then promote the usage of the research findings.[14] The result is more relevant health programs for the community.

The CBO leadership was not only enthusiastic about the maps themselves, but also about the content of the maps. They began to see how the GIS maps could provide them with evidential support for making decisions about health programming. The CBO Director noted, "The [GIS maps] showed me who the key players are [in Westside] and made me realize how much more we need to be working with other CBOs in this community." The maps were viewed by the CBO as a useful tool that continues to be used to engage other community partners in problem solving. The CBO Director has already held a number of meetings with the Unified School District, local pastors, and other stakeholders to address food security issues affecting their community.

Limitations

This study had several limitations. Data can be used to say any number of things. As public health professionals, we have to be careful when reporting data to present them precisely and objectively. Likewise,

caution must be taken when reporting statistics. Students should be adequately trained to conduct research that presents the GIS data itself and not what the data suggest. The receivers of that information must be able to interpret it and draw their own conclusions.

Furthermore, it was shown how important it is for community leaders to be able to access this information and technology. However, there are limitations to this access. First, the elements required to use this technology are costly. To solve this problem, open-source software packages and more cost-effective types of equipment are under development. The second limitation is that community leaders would need to be educated in GIS technology before using it. This process is difficult but not impossible. Initially, external support would be required.

IMPLICATIONS FOR PUBLIC HEALTH

The use of GIS in this project created avenues for change for local city officials and key community stakeholders. GIS technology is a powerful tool for public health professionals because it can be used to communicate important facts about a community.[3] For example, bus routes can be plotted in communities in which personal transportation is a commodity, revealing something about residents' access to health care. Furthermore, GIS ties health to where people live. In the case of diabetes and obesity, these diseases are influenced not only by behavior and genetics, but also by the environment. GIS is a tool that accounts for this factor and can be used, for example, to expose relationships between cancer and air quality or ground contamination. Grassroots interventions might be more easily achieved as a result.

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