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ABOUT THE COVER

The author's goal in this month's cover feature, "Nanomaterials for Environmental Remediation: Investigating the Role of Nanoinformatics in Support of Environmental, Health, and Safety Oversight of Nanotechnologies at the Local Level," was to assess future informational and scientific needs of state government agencies to regulate nanoparticles during remediation. The potential of nanotechnology in environmental remediation appears promising; however, its recent emergence means that its health and safety effects have not yet been conclusively established. The author concludes that since significant data gaps still exist on the toxicity and ecological impacts of nanomaterials, it is best to err on the side of caution in terms of exposure of workers handling them.

See page 8.

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Erratum

The contributing author information for Jin-Kyung Choi, PhD, for "Persistence of *Salmonella* and *E. coli* on the Surface of Restaurant Menus," published in the *Journal of Environmental Health*, 75(7), 8–14, is incorrect. The listed affiliation for the author should be the Department of Foodservice Management, Woosong University, South Korea.

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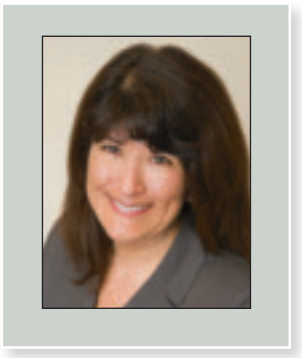


Alicia Enriquez Collins, REHS

Build Your Network With NEHA, 5,000 Strong

It is an honor to serve on NEHA's board of directors and as our association's 79th president. Our board just received word that we now have a membership that includes over 5,000 environmental health professionals from across the nation and throughout the world. This is a testament to the great work that our association is doing and to each of you for spreading the word about the benefits of belonging to the premier organization for environmental health professionals.

Thank you for the opportunity to share a bit of information about my background and a few hints about what the coming year holds for NEHA. I have been a Registered Environmental Health Specialist in California for 25 years and as of a few weeks ago, retired as the deputy division chief with the Sacramento County Environmental Management Department. I am now in Georgia with my husband Rick Collins and our beloved pets.

Along with my division chief, Mr. John Rogers, and a phenomenal management team, I led a team of extremely competent environmental health professionals and support personnel and managed numerous programs, including a quite remarkable food protection program. In January 2007, we implemented a series of food program enhancements, with the most visible component being a color-coded placard food safety rating system. This green, yellow, and red placard posting program was the first of its kind in the U.S. And, most notably, the idea for this best practice was born at NEHA's 2004 Annual Educational Conference (AEC) & Exhibition in Anchorage, Alaska, where the leadership from the Toronto Public Health Department, who created this program, shared this information.

With a network of over 5,000 environmental health professionals in NEHA, there are numerous opportunities to exchange information, to be enriched professionally, and to effect positive changes within our communities.

Making this connection with our colleagues in Toronto, Canada, through participating in the AEC was the genesis of a food safety movement in Sacramento. As a result of this networking and ability to glean from other respected organizations, retail food business operators have made food safety a priority, consumers can make informed choices when they dine, and the environmental health professionals conducting their day-to-day work have better tools to assist them during consultations and inspections. I am pleased to note that several other jurisdictions nationwide are looking closely at new food safety disclosure systems and am thankful that NEHA can assist with spreading the good word about best practice environmental health programs.

Throughout my career, I spent many years volunteering with our state affiliate, the California Environmental Health Association (CEHA), where I spent time serving on the local chapter board, serving as the CEHA secretary, and then eventually serving as CEHA president. During this time, Mr. Dick Pantages was the NEHA Regional Vice President (RVP) for Region 2 (Region 2 covers Arizona, California, Hawaii, and Nevada) and he represented NEHA at the CEHA board of directors' meetings. Dick did an excellent job of providing NEHA updates and relaying significant issues impacting our profession from a national perspective. He encouraged NEHA involvement and emphasized the importance of broadening our network so that we could share information and gain insights from others that may have already encountered similar challenges. To this day, I fondly recall these efforts by Dick and look to him as a great mentor and friend.

During my term as CEHA's president, I learned about the assistance and mentoring activities provided to affiliates by Mr. Nelson Fabian, NEHA's executive director. I invited him to meet with our CEHA executive committee to educate us and provide advice on leading an organization of our size. Our CEHA officers were pleased to receive notice that he had accepted our invitation and was going to fly to Sacramento to meet with us for several hours. We truly appreciated the time he took to understand our questions, to provide advice, and to share experiences he believed were relevant and would be helpful for us. I recently came upon a photo from that meeting and a follow-up

handwritten note from Nelson. It brought me back to the year 2000 and a full circle of mentorship and networking with our leadership at both state and national levels. My goal is to continually provide a return on those initial investments of mentorship by supporting esteemed colleagues and mentoring aspiring professionals just now entering the workforce.

Several years later, I was elected to the NEHA board of directors as the RVP for Region 2 and had the privilege of interacting and exchanging information with respected colleagues within the region. This exchange ranged from topics and/or training opportunities such as body art legislation, medical marijuana dispensaries, environmental health training in emergency response (EHTER), insect and rodent control training, Registered Environmental Health Specialist legislation and reciprocity, position papers on raw milk and sustainability, and the use of new technologies in our day-to-day work. There is never a dull moment in environmental health.

To continue on this path of information exchange, mentorship, networking, and leadership throughout the coming year, we will see even more partnerships with federal agencies, additional communication with your affiliate representatives, and award recognition opportunities for environmental health practitioners.

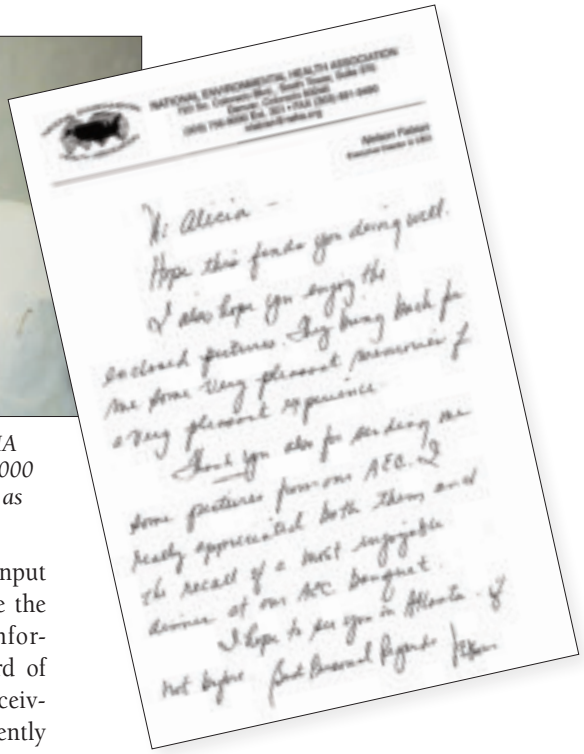
As the Food Safety Modernization Act mandates an integrated food safety system in the U.S., NEHA has partnered with the Food and Drug Administration (FDA) to assist with this effort through a five-year cooperative agreement. I just had the privilege of participating in a stakeholder meeting to begin discussions about the development of a food registry, a protected online repository that will hold information on food safety credentials, credentialing bodies, and individuals.

A blast from the past! All smiles with NEHA Executive Director Nelson Fabian at our 2000 CEHA leadership meeting during my term as CEHA president.

Our board of directors is obtaining input from your affiliate presidents to explore the most optimal methods to exchange information between affiliates and the board of directors throughout the year. After receiving input from members, your board recently approved two new awards to recognize practitioners who have made contributions to the profession by way of innovation or educational contribution.

Due to the overwhelming success and demand for the Epi-Ready foodborne illness response course, an extensive revision was completed in collaboration with the Centers for Disease Control and Prevention. A similar course to include industry representatives is also being designed in partnership with FDA and a variety of stakeholders.

These are just a few examples of NEHA's exciting activities. I look forward to leading the nation's premier organization for environmental health professionals this year with the commitment of a talented board of directors, the support of dedicated NEHA staff, and with your input. With a network of over 5,000 environmental health professionals in NEHA, there are numerous opportunities to exchange information, to be enriched professionally, and to effect positive changes within our communities. With so many environmental health issues now receiving media attention and integrated into the daily lives of our communities, we can proudly be present and available to serve our communities.



The handwritten note from Nelson Fabian that I received after our 2000 CEHA leadership meeting …who would have guessed the impact of that meeting and mentorship on my professional career and involvement in NEHA.

enriqueza@comcast.net

Did You Know?

If you were unable attend the NEHA 2013 AEC in person, you can access it online instead. About 25 sessions were recorded live and archived for you to view and learn. You can earn continuing education credits and network with environmental health professionals, speakers, and exhibitors who attended the AEC. To register for access to the Virtual AEC, visit neha2013aec.org.

Nanomaterials for Environmental Remediation: Investigating the Role of Nanoinformatics in Support of Environmental, Health, and Safety Oversight of Nanotechnologies at the Local Level

Ephraim Massawe, PhD
Department of Industrial Hygiene and Environmental Health
Southeastern Louisiana University

Abstract **Nanotechnology is the science and practice of manipulating matter at or near atomic scale to create new materials of unique and novel properties for specific applications. Nanomaterials, including engineered nanoparticles (ENPs), have been used successfully for remediation since they are superior in technical performance and cost-effectiveness than traditional remedial technologies. Evidence indicates, however, that exposure to nanomaterials may lead to significant safety and health impacts. To protect human health against undesired risks from nanomaterials requires that safe and sustainable development of nanotechnology is in tandem with the availability of relevant information.**

State agencies responsible for the environment, safety, and public health were surveyed to understand their current and future information needs and capabilities to regulate nanomaterials. Because significant data gaps still exist on the toxicity and ecological impacts of nanomaterials, precautionary measures should be taken. Research to develop techniques for exposure assessments, surveillance and monitoring, databases, and characteristics of workplaces where ENPs are used is encouraged.

Introduction

Nanotechnology has emerged as the science of manipulating small matter at or near atomic and molecular scale in order to synthesize nano-objects, devices, and nanomaterials such as thin surface coatings, nanowires, and nanotubes, which are in the scale of between 1 to 100 nm (1 nm = 10^{-9} m) in at least one, two, or three dimensions, respectively (The Royal Society & the Royal Academy of Engineering, 2004). At this scale, nanomaterials can exhibit unique and novel properties that are distinctly different from bulk materials of similar composition. These properties have made nanomaterials viable and ideal candidates for numerous applications (Alivisatos, 1996; Meyyappan, 2007; Shatkin, 2008).

After only a few decades of research in nanotechnology and nanoscale science, nanomaterials are now widely used in electronics, biomedical, and pharmaceutical or drug delivery (Bhushan, 2010; DeJong & Borm, 2008; Lane & Kalil, 2011; Murday, Siegel, Stein, & Wright, 2009; Roco, 2004; The Royal Society & the Royal Academy of Engineering, 2004; Wang, Wang, Chen, & Shin, 2008). Other applications of nanomaterials include disease diagnosis, cosmetics, alternative energy, and catalysis (Bharali & Mousa, 2010; LaRocque, Bharali, & Mousa, 2009; National Institute of Occupational Safety and Health [NIOSH], 2005; National Nanotechnology Initiative, 2011). Most recently nanomaterials have successfully been used for cleanup and pollution control (Lekas, 2006; Lien & Zhang, 2001; Meyyappan, 2007; Savage & Diallo, 2005; U.S. Environmental Protection Agency [U.S. EPA], 1997).

While the future and potential for applications of nanotechnology in environmental remediation in particular and other sectors in general appear bright, the other side of nanotechnology presents daunting challenges. Like other emerging technologies of the past, nanotechnology has ignited growing public debates on whether environmental and health aspects of its products and services outweigh social and economic benefits (Colvin, 2003; Roco, 2004). Scientific evidence indicates that exposure to nanomaterials can cause significant negative biological responses, including toxic health effects to humans and laboratory animals (Castranova, 2011; Nurkiewicz, Porter, & Hubbs, 2008; Pacurari, Castranova, & Vallyathan, 2010; Peter, Holian, & Sriram, 2008; Saga, Kommineni, & Castranova, 2007; Shvedova et al., 2008). For example, particles in the range of 1–100 nm, particularly those below 12 nm, can cross the blood-brain barrier and cause significant health impacts (Oberdörster et al., 2004; Sarin et al., 2008). A large quantity

of scientific work also confirms a strong association between exposure to nanoparticles such as carbon nanotubes (CNTs) and asbestos-like illnesses (Poland et al., 2008).

Results of many toxicology studies have either been limited or inconclusive, however, due to variability in the manifestation of the physicochemical properties of nanomaterials during production, use, or disposal; cells and the organs used for testing; biochemical assays or doses used in the studies; and lack of information on work practices to estimate exposures (Alkilany & Murphy, 2010; Colvin, 2003; Maynard et al., 2006; Nel, Madler, & Velegol, 2009). Given this lack of organized and limited information, it is logical to share what is currently known about nanomaterials in order to support the regulatory oversight of nanotechnologies and prevent potential exposures to nanomaterials and work-related and public health risks. Thus, the overall goal of this article is to assess current and future information and scientific needs and capability of the state government agencies to regulate nanoparticles during remediation. This approach is within the framework of nanoinformatics (information science), "the study of processing, management, and retrieval of information," and it helps to equip professionals and agencies at the local level with necessary tools to *anticipate, recognize, evaluate, and control* potential health hazards in the handling of nanomaterials (Hoover et al., 2011; National Nanomanufacturing Network, 2011).

Materials and Methods

Study Design and the Use of Focus Groups

From April through June 2011, four focus groups comprising various experts in nanotechnology research and consulting were assembled for discussions with the main goal of generating generic themes and a framework to study and understand scientific and information needs at the state government agencies' level. In essence, this would support regulatory oversight of engineered nanoparticles (ENPs) during remediation and throughout their life cycle: synthesis and testing, manufacture, storage, distribution, uses, and disposal.

Focus group members consisted of professionals from various backgrounds, including public health professionals, industrial hygienists, safety professionals, medical scientists, academics, and environmental health specialists. They were assembled via webinar, telephone, and online. Other groups were requested to meet for face-to-face discussions during monthly professional meetings. Individuals in the focus groups were identified from previous professional networking experience. Some members of the focus groups were identified as previous faculty mentors, colleagues, and faculty members at a university who either conduct nanotechnology research or those developing and teaching in these specialized fields. Other focus group members were identified from the state and local government agencies' Web sites, with emphasis on those agencies responsible for air, water, and soil quality.

The focus group strategy was used as it can capture varied opinions of experts in a specific field (Deggs, Grover, & Kacirek, 2010). This method is efficient, cost-effective, and saves time in collecting data. The focus group has become more reliable now than ever before because of the emergence and growth of Internet use, including various forms of the online chat services now available (Stancanelli, 2010). Despite the advantages of using the online focus group methods in research, a disadvantage exists due to the need for highly skilled personnel to moderate the groups (Deggs et al., 2010).

Other methods used to collect data included face-to-face and telephone semistructured interviews. Telephone interviews complimented face-to-face interviews when it was difficult to travel to the agencies' offices to meet in person. While questionnaires can be a great resource for collecting and collating evidence and patterns in a study, data obtained using a semistructured interview can provide more in-depth and significant insights on particular respondents' reactions to issues or themes (Kendall, 2008).

Identification of Contacts for the State Agencies and Programs

As part of measuring and assessing current and future scientific and technical information needs of regulatory agencies and programs at the local and state government levels across the country, contacts for the state agencies were identified using the information available online and in professional journals. The focus groups' experts also proposed some contacts and agencies that were likely to be involved with the regulatory oversight of nanomaterials during environmental remediation. A total of 740 potential participants were identified across the country. Due to incorrect contact information (e-mail, telephone, and facsimile numbers), only 606 were contacted.

Literature Review

Literature review consisted of government documents, circulars, and bulletins, which provided baseline information to learn about the functions and efforts of the regulatory agencies in the context of safety and health oversight of nanomaterials at the local and state government level. In addition, peer-reviewed scientific and technical journals and articles on toxicology and documents recommending best practices while working with nanomaterials that have been issued by scientists working with nanomaterials and federal agencies, such as the U.S. Environmental Protection Agency (U.S. EPA), the Occupational Safety and Health Administration (OSHA), or the National Institute for Occupational Safety and Health (NIOSH), were reviewed. While some articles and journals were freely available online, other journal articles were obtained either through subscription or interlibrary loans.

Design of the Questionnaire

The survey questionnaire was designed by using the information sources from literature (Browne, 2005; Dillman, 2007). The content of the questionnaire was based on themes in the framework developed with the support of face-to-face discussion and the ideas from the online focus groups members. Most questions were designed to take into consideration as many themes in the framework as possible. Altogether, 78 open-ended and closed questions were created using SurveyMonkey software. This mixture of questions was used with the realization that in open-ended questions, individual respondents can give spontaneous answers to the questions raised and a researcher can also avoid the bias associated with suggesting responses (Reja, Manfreda, Hlebec, & Vehovar, 2003).

Administration of the Survey Questionnaire

From August through October 2011, questionnaires were distributed to participants via SurveyMonkey software. An introductory letter stating the objectives of the study and an insti-

tutional review board approval letter of exemption for testing of human subjects accompanied the questionnaire. The letter stated that the survey was voluntary and should take only about 15–20 minutes to complete. In the letter, participants were also told to feel free and comfortable in answering any and all questions.

Follow-up telephone calls were initiated three weeks after the first letter was sent out, and after four weeks, a follow-up e-mail was sent out to remind respondents that the time for taking the survey was running out. From October through November 2011, two additional follow-up e-mails were sent, which were justified by the low number of responses that had been received.

The last follow-up e-mail contained the following questions. Q1: Has your agency discussed any potential environmental or health impacts of nanomaterials? Q2: If so, at what level of specificity? Have these discussions yielded any actions? Q3: Do you ever discuss these matters with officials in other states, or in the federal government? Please elaborate. Q4: If not, has any other agency in your state done so? Have any results, to your knowledge, come of these discussions? Q5: If not, do you expect such a discussion to occur in your state anytime soon?

Two undergraduate students followed up with telephone calls to remind the state agencies' contact persons about the survey. The main limiting factors included lack of updated contacts and lack of interest from participants to return telephone calls or respond to the survey.

Data Analysis

After data collection, each question was analyzed separately, and where possible, descriptive statistics were calculated to summarize the observations from the data. Where no contact information was provided, the Google search engine was used to determine the exact location of the IP address, and therefore it was possible to identify the state agency or federal agency represented.

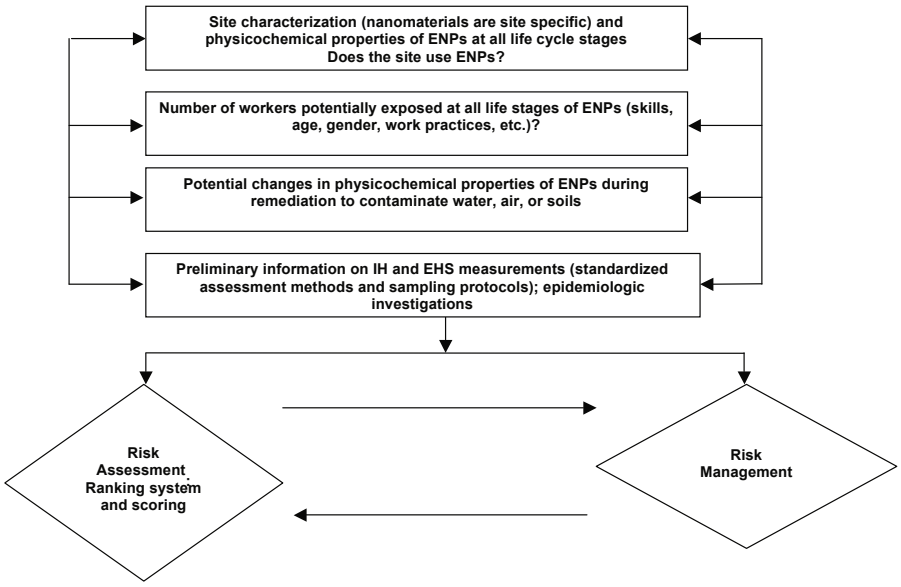
Results and Discussion

Framework to Understand Information and Technical Needs at the State and Local Levels

A framework (Figure 1) that was a result of the focus group discussions was developed and used to design relevant questions in a systematic way to understand current and future information needs of various local and state government agencies and programs.

FIGURE **1**

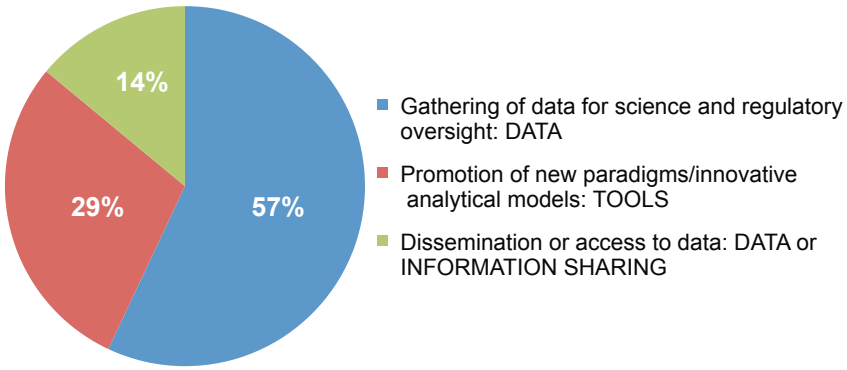
A Flow Diagram to Understand Technical and Information Needs of the State Agencies to Support Regulation of Nanomaterials Use During Environmental Remediation



ENPs = engineered nanoparticles; IH = industrial hygiene; EHS = enviromental health and safety.

FIGURE **2**

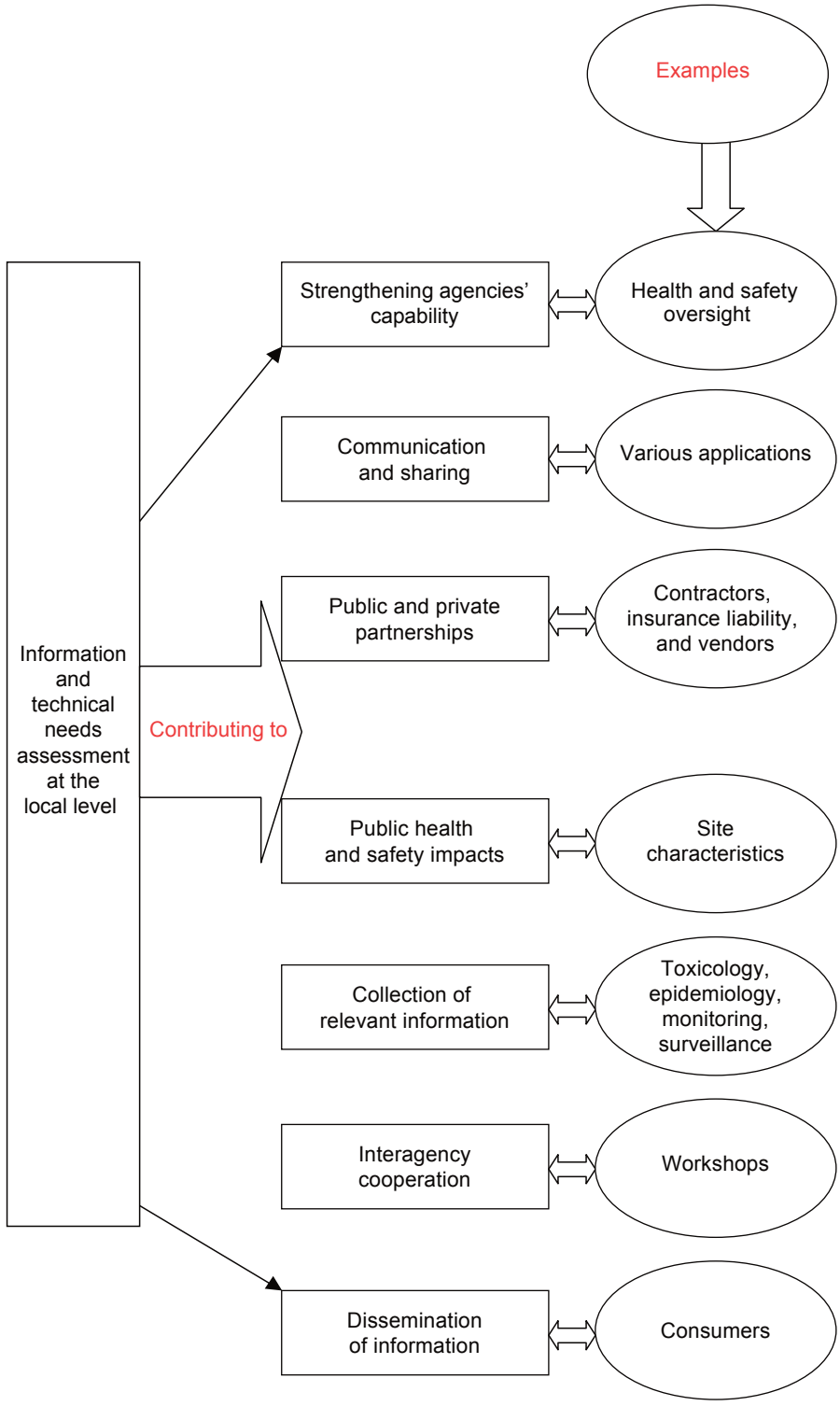
Expert Opinions on Data Collection, Tools for Exposure Modeling, and Information Sharing



This framework shows a minimum number of broad themes needed to ensure that safety and health protection of the workers and the general public are guaranteed during the entire life cycle of nanomaterials, not

FIGURE **3**

Questions and Responses From the State Agencies and Programs



only in remediation applications but also in other areas where they are used. For example, it became clear that understanding site characteristics and physical chemical properties of nanomaterials would increase the knowledge about the potential for these materials to agglomerate or coagulate during remediation. Agglomeration of nanomaterials is a property that can change other properties of nanomaterials, such as particle size and shape, both of which have a strong correlation with biological reactivity and potential to cause a significant negative health response (Castranova, 2011). It is equally important to understand how properties of nanomaterials change during various stages of the supply chain in order to determine how nanomaterials used for remediation could simultaneously contaminate water or could become an exposure of concern to human health.

In developing this framework, input from the focus group experts presented varied opinions on the three-tiered approach: 57% recommended gathering data for health and safety as well as data on science and regulatory oversight; and while 29% preferred to gather tools to promote innovative models for exposure and risk assessment, 14% proposed information on better methods of disseminating the data (Figure 2).

Based on the framework shown above, focus group experts indicated that in the absence of protocols for conducting measurements and assessment, and due to lack of instrumentations and analytical methods, information to support quantitative and qualitative models for predicting health risks of nanomaterials and their availability, accessibility, and dissemination would significantly support regulatory functions at the local and state government levels. All the views presented by experts were collated and aggregated to improve the framework, which resulted in an updated schematic framework shown in Figure 3.

Study Population and Characteristics

A total of 606 representatives of various state agencies and programs across the country were contacted using SurveyMonkey and 196 completed the online surveys, for a 32.3% response rate. All 10 U.S. EPA regions were represented by at least one respondent; however, not all other agencies, such as public health or natural resources departments, were

equally represented. Thus, most responses were from environmental agencies, which are closely associated with remediation work. The characteristics of these respondents are shown in Table 1.

Current Activities and Key Issues on Nanomaterials, Nanotechnology, and Nanoinformatics

Approximately 25% of respondents were unaware of how many Superfund sites are in the state jurisdictions, but 31% said that no Superfund sites were present in their respective states. This may not be authentic information, however, because it is known that 1,200 U.S. EPA Superfund sites are spread across the country and need either removal or remedial actions (Kubasek & Silverman, 2011). About 12.5% of respondents indicated that they had more than 30 Superfund sites in their state.

Traditional and Nano-Enhanced Environmental Remediation Technologies

Since 2001, U.S. EPA has conducted successful environmental remediation using nanomaterials at pilot and full-scale experimentations on at least 20 Superfund sites (Karn, Kuiken, & Otto, 2009; Li, Elliott, & Zhang, 2006; Otto, Floyd, & Bajpai, 2008; Su et al., 2008; U.S. EPA, 2007a). At present the trend shows more sites may want to use nanomaterials for this purpose, and the need for information will become increasingly important. Literature has revealed several traditional remediation technologies including thermal desorption, incineration, vitrification, pump and treat, acid leaching, bioremediation, and phytoremediation (U.S. EPA, 2007b). While 60%–80% of the respondents were not aware of the exact number of sites that employ traditional remediation technologies, only 5%–10% reported knowing of 1–5 sites doing so within their state jurisdictions. The level of awareness among the respondents about Superfund sites using nanomaterials for remediation or agencies that were responsible for safety and health oversight of nanotechnology during remediation was low (Table 2).

The literature also indicates that nanotechnologies are increasingly becoming a reality in U.S. EPA Superfund sites. Table 3 shows a list of typical nanomaterial candidates for environmental cleanup. These include ENPs or metal oxides, zeolites, dendrimers, and

TABLE **1**

Key Characteristics of the Online Survey Respondents (*N* = 606)

Characteristic: Personal and Agency or Program Information	Response Rate # (%)
Gender	No response
Age group	
<20	0 (0)
20–30	18 (2.9)
30–40	103 (17.1)
40–50	173 (28.6)
50–60	190 (31.4)
60–70	69 (11.4)
>70	0 (0)
No response	52 (8.6)
Number of years working as regulatory professional	
0–5	52 (14.3)
5–10	34 (5.7)
10–15	121 (20.0)
15–20	138 (22.8)
>20	207 (34.3)
No response	176 (2.9)
Number of years dealing with nano-related issues	
0	311 (51.4)
<2	121 (20)
2–5	121 (20)
5–10	34 (5.7)
>10	0 (0)
No response	17 (2.9)
Willingness to provide input in the study and to have contact information in final report	
Willing to provide input and to have contact information appear in the final reports	207 (34.3)
Not willing to provide input and to have contact information appear in the final reports	346 (57.1)
No response	52 (8.6)
Willingness to review the first draft of the report	
Yes, respondent is willing to review first draft of the report	295 (48.6)
No, respondent not willing to review first draft of the report	277 (45.7)
No response	34 (5.7)
Region	
U.S. Environmental Protection Agency (U.S. EPA) Region 1: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont	34 (5.7)
U.S. EPA Region 2: Commonwealth of Puerto Rico, New Jersey, New York, and the Virgin Islands	34 (5.7)
U.S. EPA Region 3: Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia	17 (2.8)
U.S. EPA Region 4: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee	121 (20.0)
U.S. EPA Region 5: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin	34 (5.7)
U.S. EPA Region 6: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas	156 (25.7)
U.S. EPA Region 7: Iowa, Kansas, Missouri, and Nebraska	52 (8.5)
U.S. EPA Region 8: Colorado, Montana, North Dakota, South Dakota, and Utah	17 (2.8)
U.S. EPA Region 9: American Samoa, Arizona, California, Commonwealth of North Mariana Islands, Guam, Hawaii, and Nevada	69 (11.4)
U.S.EPA Region 10: Alaska, Idaho, Oregon, and Washington	69 (11.4)
Budget for information gathering, analysis, and sharing	
$0	489 (80.8)
<$10,000	101 (16.7)
No response	16 (2.5)

TABLE **2**

Information Needs for Safety and Health Oversight of Nanomaterials During Environmental Remediation (*N* = 606)

Online Survey Question	Response Rate # (%)
Number of Superfund sites conducting clean-up operations with nanomaterials	
Not sure	392 (64.7)
0	82 (13.5)
0–5	106 (17.8)
>5	0 (0)
No response	19 (4.3)
Number of agencies responsible for regulating nanomaterials in various states	
Not sure	428 (70.6)
0	0 (0)
1	72 (11.8)
2	36 (5.9)
3	36 (5.9)
4	0 (0)
>5	36 (5.9)
No response	0 (0)
Has your agency ever had meetings to discuss regulatory issues pertaining to nanomaterials or their health impacts?	
Yes	142 (23.5)
No	463 (76.5)
No response	2 (2)

TABLE **3**

Common Nanomaterials for Environmental Remediation

Type of Nanomaterials	Examples	Specific Environmental Remediation Application
Bimetallic nanoparticles and zero valent iron	Nanoscale zero valent iron (nZVI); emulsified zero valent iron; bimetallic nanoscale particles, e.g., nickel, gold, palladium, and platinum	Remediation of complex hydrocarbons in water, soils, or sediments
Metal oxides (natural or engineered nanoparticles [ENPs])	Titanium dioxide; zinc dioxide; cerium oxide	
Nanometals	Engineered nano silvers	
Carbonaceous ENPs	Multi-walled carbon nanotubes	Sorption of metals, e.g., cadmium, lead, copper, etc.
	Nonporous activated fibers	Sorption of benzene, toluene, ethyl benzene, and xylenes (BTEX compounds)
Nano clays/zeolites	$Na_6Al_6.Si_{10}.12H_2O$	Sorption/ion exchange for heavy metals
Dendrimers	Hyper branched polymers (1–20 nm)	Polyaromatic hydrocarbons; ultra-filtration of heavy metals

Sources: Lien & Zhang, 2001; Savage & Diallo, 2005; Su et al., 2009; U.S. Department of the Interior Bureau of Reclamation, 2009.

carbon nanotubes (Bruck, 2007; Karn et al., 2009; U.S. Department of the Interior Bureau of Reclamation, 2009).

The list is long but not exhaustive because other nanomaterials are capable of decontaminating inorganic heavy metals and persistent organic pollutants that can bioaccumulate or are toxic (Bruck, 2007; Wang & Zhang, 1997). Since 2001, U.S. EPA has started and completed remediation on more than 20 Superfund sites using nanomaterials (Karn et al., 2009; Li et al., 2006; Otto et al., 2008; Su et al., 2008; U.S. EPA., 2007a, 2008). Available information shows that traditional remediation technologies are more expensive and can consume more time than the use of ENPs (Otto et al., 2008). Obviously, in comparison to the costs associated with using reactive barriers or pump-and-treat traditional remediation technologies for complex hazardous wastes, it is less costly to use nanomaterials for environmental remediation (Table 4). The state of New Jersey estimated that using nano-enhanced remediation to be 20–250 times faster than traditional remediation technologies (Muller & Nowack, 2010). Based on these economics, using nanomaterials for remediation will save the nation more than $250 billion required to decontaminate hazardous sites across the country and will also make the contaminated land available for economic use (U.S. EPA, 2004).

Lack of knowledge on the work practices and different tasks such as transport and preparation of nanomaterials and final use for cleanup operation impedes regulatory functions, including efforts to estimate health effects associated with exposure to nanomaterials. The availability of this information can help professionals to estimate the duration, frequency, and levels of exposure and potential dose or toxicity associated with the applications of nanomaterials. Furthermore, lack of information on other aspects of nanomaterials that define their toxic properties hinders prospects for limiting exposures to nanomaterials (Castranova, 2011).

It is important to understand that while plenty of toxicity data gaps for a great number of nanomaterials still exist, nano zero valent iron (nZVI), which is largely used for remediation, is "just iron," so why worry? But others have noted that nano-scaled "anything" actually can have different biological effects on humans and animals than the same compounds at micro or larger scales. If any

emerging product is approved for consumer use and other applications on the basis of the current knowledge or lack of known threats and it happens to be a disaster 50 years later, it would be a mistake and a repeat of the era of dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs).

Information Sharing and Guidance Documents in Federal Government Institutions or Agencies

As always has been the case, state government agencies and programs can use and share information with federal agencies. At present, however, state agencies indicated limited budgets for information gathering or sharing to address nanotechnologies in general and remediation in particular. At least 80% indicated they did not have any budget for this particular line of use, and 16.7% stated that they had allocated less than $10,000 for this purpose (Table 1).

Even when state agencies rely so heavily on federal agencies for information, very limited nano-specific information, regulations, and standards exist at the federal level in relation to nanomaterials. For current information, state agencies stated that they relied on OSHA (80%) and NIOSH (90%). Other sources of information included local and international research and institutions (2%–20%). NIOSH has issued two bulletins, both of which provide the basis for developing good work practices and the recommended exposure levels (NIOSH, 2010, 2011). These bulletins address two commonly used nanomaterials: titanium dioxide and CNTs. While the recommended exposure levels (RELs) for ultra and fine titanium dioxide are set at 0.3 mg/m^3 and 2.4 µg/m^3, respectively, the REL for CNTs is 7 µg/m^3 as elemental carbon at an eight-hour time-weighted average as respirable mass airborne concentration (NIOSH, 2010).

NIOSH recently issued "General Safe Practices for Working With Engineered Nanomaterials in Research Laboratories (NIOSH, 2012)." In this document, recommended methods of exposure assessments, controls, and confirming that the hazard control methods work are provided. NIOSH previously issued a document entitled "Approaches to Safe Nanotechnology—Managing the Health and Safety Concerns Associated With ENPs (NIOSH, 2009)." U.S. EPA also recently issued a document entitled "Guidance to Facilitate Decisions for Sustainable Nanotechnology (Eason, Meyer, Curran, & Upadhyayula, 2011)." Several federal environmental legislations may apply for oversight of nanomaterials during remediation. For example, the Toxics Substances Control Act authorizes U.S. EPA to limit the production, processing, use, and disposal of new chemicals. The Resources Conservation and Recovery Act (RCRA) can be useful to state agencies for cradle-to-grave management of hazardous materials. Since RCRA defines a hazardous substance as one which possesses reactivity, pH, corrosivity, and flammability, once information is generated for nanomaterials, their characterization in the context of RCRA can become clearer and their management controlled under this federal legislation.

In the context of regulatory health and safety oversight of nanomaterials during environmental remediation, a breakdown of responses is as follows: while 55% of respondents considered physicochemical properties and toxicity of nanomaterials as "extremely relevant," only 40% and 32% similarly rated information on exposure scenarios or work practices and the population at risk, respectively. The following information was rated of "extreme importance" by 20%–40% of the regulatory agencies surveyed: number of employees on site, work practices, and the geographical location of the Superfund site; modules and level of training available to workers; information on licensing requirements for contractors and effective safety and health programs; knowledge for emergency response at the local level; and results of surveillance, monitoring, and treatment or remediation technologies used at the site. Fifty percent to 65% of the respondents rated all this information as "important."

The information reflecting the need for knowledge in legal liability of nanomaterials during synthesis and transportation was ranked of the highest importance (40%) in comparison to information required to predict or regulate groundwater contamination (24%). This is relatively significant because during the synthesis of nZVI, boron and boron oxide nanoparticles are significant by-products of the process. Scientific reviews of boron nanoparticles as solid fuels and propellants in civilian and military applications have indicated that their mobility in natural organic matter can have far-reaching consequences and ramifications in the natural environment, especially if large-scale production of nZVI is envisaged in the future (Liu, Wazne, Christodoulatos, & Jasinkiewicz, 2008; Liu, Wazne, Han, Christodoulatos, & Jasinkiewicz, 2010; Strigul et al., 2009). While 54% of respondents indicated that information to prepare for emergency spillage was "very important," 46.5% indicated that information pertaining to flammability, reactivity, or fire hazards of nanomaterials was only "important" in such emergency situations.

Information for Risk Assessment and Risk Management

The relatively few scientific studies to provide conclusive determination between exposures, toxicity, or ecological fate and transport of nanomaterials suggest that while solid science and knowledge about the toxicity of chemicals can make it easy to protect human health and safety, lack of such information should not be an excuse not to act (Martuzzi & Tickner, 2004). In the face of uncertainty, the best approach is to err on the part of the precautionary principles, where the burden of proof lies with the manufacturers to generate toxicity information on nanomaterials.

TABLE **4**

Economic Incentives for Promoting Nano-Enhanced Remediation

Remediation Technology to Decontaminate Trichloroethylene and Perchloroethylene Contaminants	Cost of Remediation
Traditional remediation methods using pump and treat (without nano-enhancement)	$5,500,000
Traditional remediation methods, e.g., permeable reactive barriers	$3,400,000
Nano-enhanced remediation methods using nano-zero valent iron	$600,000

Source: Muller & Nowack, 2010.

Conclusion and Recommendations

Nanotechnologies for remediation will increase in the future, and therefore safe and sustainable use of nanomaterials for remediation of Superfund sites based on current knowledge will be needed. The unknowns in this equation are the short- or long-term effects of nanomaterials. The preliminary findings of this study suggest that health and safety of workers handling ENPs can be enhanced by accessing relevant information. A large percentage of the state agencies and programs have little understanding of the number of contaminated sites or nanotechnologies or nanomaterials within their state jurisdictions. Inquiry into understanding their information needs, however, should continue to focus on specific data as related to the characteristics of hazardous sites; remediation technologies; and number, age, sex, and other medical conditions of workers as part of surveillance and monitoring. While information on work practices including job titles and tasks is needed to support exposure assessment, intra- and interstate agency information sharing as well as information sharing between states and the federal government, particularly as it relates to occupational and nonoccupational exposure standards, are lacking. To improve this situation, awareness raising and use of other methods of sharing and communicating the information among stakeholders and agencies such as use of databases and training should be enhanced.

Technical and scientific information needs should include supporting the state agencies' main goals and mission of regulatory oversight of nanomaterials as new products in order to protect human health and the environment. In this regard, information on physicochemical properties of nanomaterials, work practices and processes, exposure sources, scenarios and pathways, and the fate and transport mechanisms of these materials should also be communicated to public. Measurement methods such as dosimetry, surveillance, and monitoring for epidemiological studies and basic information on safety and health programs such as chemical hygiene programs can generate information required to support the work of state agencies. A significant amount of work is therefore needed to organize databases of information in the form of the types of nanomaterials synthesized and their functions, potential for toxicity, properties, and other keywords that can easily be used by the state agencies in search of information for regulatory oversight of nanomaterials. While significant data gaps still exist for nanomaterials, a precautionary approach should be taken to avoid exposure while working with nanomaterials. In addition, research should continue to focus on exposure scenarios (workers and public) including databases on surveillance and monitoring.

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Baseline Knowledge Survey of Restaurant Food Handlers in Suburban Chicago: Do Restaurant Food Handlers Know What They Need to Know to Keep Consumers Safe?

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Abstract **In the U.S., foodborne disease causes millions of illnesses annually, resulting in thousands of deaths. To reduce food poisoning, restaurant food handlers need accurate knowledge of food safety principles as a starting point for the outcome of optimal food safety behavior. The study described in this article determined food safety knowledge gaps among suburban Chicago restaurant food handlers. A cross-sectional survey of 729 food handlers at 211 suburban Chicago restaurants was conducted from June 2009 through February 2010. A 50-question survey was administered by a trained interviewer in either English or Spanish. Mixed-effects regression analysis identified risk factors associated with an overall food safety knowledge score. The mean overall knowledge score was only 72% and substantial knowledge gaps related to cross contamination, cooking, and holding and storage of food were identified. Spanish-speaking food handlers scored significantly lower than English-speaking food handlers ($p < .05$). Although certified food managers scored significantly higher than noncertified food handlers, their score was only 79%. These data provide targets for educational interventions to remedy knowledge gaps in food handlers in order to prevent food poisoning from restaurants.**

Introduction

Each year, an estimated 48 million illnesses and 3,000 deaths can be attributed to the consumption of food (Scallan et al., 2011; Scallan, Griffin, Angulo, Tauxe, & Hoekstra, 2011). The majority of foodborne outbreaks in the U.S. are attributed to food service establishments and are most frequently reported from restaurants (Todd, Greig, Bartleson, & Michaels, 2007). In 2008, 868 single setting foodborne disease outbreaks in the U.S. were reported to the Centers for Disease Control and Prevention (CDC) and approximately 52% were associated with restaurants or delicatessens (Gould et al., 2011). In Illinois, the proportion of outbreaks associated with restaurants is even higher (56%) (Centers for Disease Control and Prevention [CDC], 2011a).

According to the Food and Drug Administration (FDA), the most common food handler behaviors contributing to foodborne outbreaks include poor hand hygiene, improper temperatures for cooking and holding food, and cross contamination (FDA, 2009). A recent observational study by Green and co-authors (2006) reported that approximately one-fourth of food handlers did not always wash their hands, one-third did not change gloves between touching raw meat and ready-to-eat food, and slightly more than one-half did not use a metal stem thermometer to check the temperature of cooked food.

Although food handler observational studies have been performed by researchers in the U.S. (Green et al., 2006; FDA, 2009; Strohbehn, Sneed, Paez, & Meyer, 2008), few studies have been published assessing restaurant food handler knowledge (DeBess, Pippert, Angulo, & Cieslak, 2009; Dworkin, Udompat, Panchal, & Liu, 2011; Panchal, Liu, & Dworkin, 2012). Panchal and co-authors (2012) reported food safety knowledge among restaurant food handlers in the city of Chicago; however, in a suburban region, public health resources and other local factors may vary substantially. Given the large amount of food prepared by restaurant food handlers, an assessment of their knowledge of safe food handling practices is necessary and can be useful in designing educational materials that target these knowledge gaps (Dworkin et al., 2011; Panchal et al., 2012). A lack of food safety knowledge can lead to unsafe food handling behaviors that put customers at risk for food poisoning.

Currently, no federal food safety training requirements exist for restaurant food handlers in the U.S. Instead, states, counties, or cities set training and certification standards independently. As a result, food handler edu-

cational requirements vary throughout the country and range from no required training to extensive training courses required for every food handler (California Retail Food Code, 2011; Wyoming Department of Agriculture Consumer Health Services Section, 2009). In Illinois, certified food managers must attend a Food Service Sanitation Manager Certification (FSSMC) training course and pass a certification exam (Illinois Administrative Code, 2008). Understanding whether or not certified food managers and their staff have adequate food safety knowledge is critical to preventing foodborne disease outbreaks. Although local health departments routinely inspect restaurants, these inspections do not involve standardized knowledge examination; rather, they determine momentary compliance with local food codes.

The objective of our study was to determine food safety knowledge gaps of food handlers in the suburbs of Chicago. Analysis of these data can determine areas most in need of improvement. The ultimate goal is to develop targeted educational materials that increase knowledge and result in improved food safety behavior and decreased risk for restaurant-associated food poisoning.

Materials and Methods

Sample and Participants

We obtained a list of 2,087 food establishments in Lake, Kane, and suburban Cook counties from the business credibility provider Dun & Bradstreet (www.d&b.com). The list was restricted to restaurants only. It excluded banquet halls, caterers, and establishments that serve only nonperishable packaged foods and were otherwise considered low risk by the health department (Chicago Department of Public Health, 2011). A random sample of 668 restaurants (32%) was selected to be approached. We interviewed 729 food handlers from 211 participating restaurants from June 2009 through February 2010. Restaurant managers were approached in person for verbal approval to conduct interviews with the staff at each restaurant. Unless a restaurant refused to participate, they were approached up to 10 times to obtain permission directly from a manager. If the manager neither refused nor consented or was not able to be contacted, the restaurant was determined to be "not available." For larger restaurants, interviews were limited to 20 to maximize enrollment and not over-represent any single restaurant. A signed consent was obtained that required participants to be 18 years or older, and confidentiality of food handler and restaurant name were ensured. Eligible participants were food handlers defined as a restaurant employee who prepares food to be consumed by the patrons. Food preparation was defined as washing, cutting, cooking, or placing food onto a plate. Restaurant employees who only poured drinks or carried plates to tables were not eligible to participate. Eligible participants were also required to speak either English or Spanish as the survey was administered in one of these two languages. Surveys were administered in English or Spanish by public health–trained graduate students from the University of Illinois at Chicago and Survey Research Laboratory staff and completed discreetly at the restaurants. Participating food handlers were offered a compensation of $15.00. Approval from the University of Illinois at Chicago institutional review board for the protection of human subjects was received prior to survey initiation.

Instrument Development and Data Collection

A 50-question survey instrument was developed to obtain baseline information on restaurants and knowledge, behaviors, and personal hygiene among the food handlers. Survey development included input from the Chicago, Cook County, DuPage County, Kane County, and Lake County health departments; Illinois Department of Public Health; and the University of Illinois at Chicago Survey Research Laboratory. Cognitive interviewing was performed with both English- and Spanish-speaking food handlers and survey adjustments were made accordingly.

The final survey instrument was launched after a pretest was completed. The 40 food safety knowledge questions included true/false, multiple choice, and fill-in-the-blank format and tested knowledge of the optimal temperatures for bacterial growth, appropriate temperatures for heating and cooling foods, cross contamination, and when to discard food. Participants were also asked about behavior practices including hand hygiene and working while ill. Food handler demographic information was collected and included primary language (English, Spanish with or without the ability to speak English, and other language with the ability to speak English), race/ethnicity, history of food safety training and certification, years of food handling experience, and frequency of specific food handling tasks (including handling and cooking raw meat/poultry, seafood, eggs, and vegetables/fruits). Restaurant characteristics including service style, food type, and average entrée price were obtained. Restaurants were categorized by size: small (≤10 tables or seating ≤40 seats), medium (11–29 tables or seating 41–119 seats), and large (≥30 tables or seating ≥120 seats).

Statistical Analysis

Statistical analysis was performed using SAS 9.2 for Windows with data from 722 of 729 (99%) food handlers with no missing information. Overall knowledge score was determined by the proportion of correctly answered knowledge questions of the 40 from the survey. Bivariate analyses were performed to identify food handler or restaurant variables associated with the knowledge score. *t*-Tests were performed to compare the mean knowledge scores between two category variables, and analysis of variance models with Tukey's pairwise comparisons were employed to compare the mean knowledge scores for variables with more than two categories. Pearson correlation coefficients were calculated to describe the relationship between the knowledge score and continuous variables. To identify risk factors associated with the food handler knowledge score, multivariate analysis was performed using mixed-effects regression models predicting knowledge score. A random restaurant effect was used to account for the potential correlations between food handlers from the same restaurant. Variables of primary research interest such as primary language and those that had a statistically significant association ($p < .1$) with the knowledge score were included in the multivariate analysis. The initial regression model included all significant food handler and restaurant characteristics to predict the knowledge score. A backward elimination method with a probability of Type I Error of $\alpha = .10$ was used to determine the significant food handler and restaurant characteristic variables to remain in the final mixed-effects regression model.

Results

From June 2009 to February 2010, all 668 randomly sampled restaurants were approached and 32% (211) of the restaurants participated in the survey. The reasons that 457 restaurants did not participate included refusal (23%, 156), restaurant was "not available" (9%, 63), closure or vacancy (9%, 58), no English- or Spanish-speaking food handlers (13%, 89), not meeting the inclusion criteria (6%, 41), and having changed names or moved locations (8%, 50). In participating restaurants, 99% of the immediately available food handlers consented to participate in the survey.

Of the 211 restaurants, 42% (88) were medium-sized, 58% (121) had informal dining, and 64% (235) had an average entrée price of $10.00 or less (Table 1). Approximately half of the restaurants served American cuisine with no ethnic focus (51%, 107). Among the 722 food handlers interviewed, English was the primary language for 49% (356), Spanish for 41% (295), and other primary language for 10% (71) (Table 2). Although many of the food handlers were Spanish speaking, only 18% of the restaurants served Mexican cuisine. The mean age of the participants was 32 years (range: 18–68 years) and 61% were male. Forty-four percent (306) described themselves as non-Hispanic Caucasian, 40% (275) as Hispanic/Latino, 4% (26) as non-Hispanic African-American, 6% (38) as Asian/Pacific Islander, and 7% (77) as multiracial or other race/ethnicity. Fifty-three percent (381) of the food handlers had no more than a high school education. The proportion of Spanish-speaking food handlers having only achieved a high school education was much higher compared to English and other primary language speaking food handlers (84% compared to 30% and 34%, respectively).

The average time spent working as a food handler was 9.9 years (range: 0.2–48 years). Food handler age and experience were highly correlated ($r^2 = .73$, $p < .0001$). Many of the participating food handlers had never taken a food safety training course (39%, 285) or reported receiving no food safety training at their current job (34%, 244). Certification was lower among food handlers with less food handling experience (40% among those working as a food handler for <1 and 1–3 years, 60% among those working 3–6 years, 73% among those working 6–10 years, and 80% among those working >10 years). Of the 722 food handlers, 35% (254) were certified food safety managers and approximately half reported English as their primary language (51%, 129). The proportion of food handlers who had at least some college education was substantially higher for certified food managers compared to noncertified food handlers (56% and 39%, respectively).

TABLE **1**

Characteristics of Restaurants Participating in a Knowledge Survey in Suburban Cook, Lake, and Kane Counties, Illinois, 2010 (*N* = 211) and Score Out of 40 Food Safety Knowledge Questions

Characteristic	Frequencies		Bivariate Analysis	
	Restaurant *n* (%)	Food Handler *n* (%)	Mean Score (%)	*p*-Value
Restaurant size				<.0001
Small (≤10 tables or ≤40 seats)	70 (33)	169 (23)	29.7 (74)	
Medium (>10 tables or >40 seats but <30 tables or <120 seats)	89 (42)	276 (38)	29.6 (74)	
Large (≥30 tables or seating ≥120 seats)	52 (25)	277 (39)	28.1 (70)	
Food service style				.3507
Fast food	61 (29)	173 (24)	28.7 (72)	
Informal (diner, delicatessen, other casual)	122 (58)	459 (64)	29.2 (73)	
Formal	28 (13)	90 (12)	29.4 (74)	
Cuisine				.0012
American (no primary ethnic focus)	107 (51)	456 (63)	29.5 (74)	
Mexican	38 (18)	96 (13)	28.4 (71)	
Italian	26 (12)	93 (13)	28.0 (70)	
Other	40 (19)	77 (11)	27.8 (70)	
Food specialization				.5371
Meat or poultry	48 (23)	223 (31)	28.9 (72)	
Seafood	5 (2)	41 (6)	28.5 (71)	
No specialization but meat, poultry, and/or seafood served	158 (72)	458 (63)	29.1 (73)	
Buffet served at least two hours per day				.9004
Yes	22 (10)	80 (11)	29.0 (73)	
No	189 (90)	642 (89)	29.1 (73)	
Chain or independent				.0654
Chain	69 (33)	365 (51)	28.9 (73)	
Independent	142 (67)	357 (49)	29.4 (73)	
Average entrée price				.0214
≤$10	135 (64)	408 (57)	28.8 (72)	
>$10 but <$20	69 (33)	281 (39)	29.2 (73)	
≥$20	7 (3)	33 (5)	31.0 (78)	

The food handlers in our study performed various food handling tasks at least some of the time in the restaurant. Sixty-eight percent were responsible for handling raw meat or poultry, 42% were responsible for handling raw seafood, 46% were responsible for handling raw eggs, and 90% were responsible for handling raw vegetables or fruits. Fifty-six percent were responsible for cooking meat or poultry, 37% were responsible for cooking seafood, and 40% were responsible for cooking eggs.

Identifying Knowledge Gaps

The overall food handler mean knowledge score was 72% (29/40). Among the more substantial knowledge gaps identified, several were related to optimal temperatures

TABLE **2**

Characteristics of Food Handlers Participating in a Knowledge Survey in Suburban Cook, Lake, and Kane Counties, Illinois, 2010 (*N* = 722) and Score Out of 40 Knowledge Questions

Characteristic	Frequencies	Bivariate Analysis	
	n (%)	Score (%)	*p*-Value
Age (years)			.0001
18–29	332 (46)	28.1 (70)	
30–39	182 (25)	29.4 (74)	
40–49	121 (17)	30.3 (76)	
≥50	87 (12)	30.4 (76)	
Gender			.9802
Males	437 (60)	29.1 (73)	
Females	285 (40)	29.1 (73)	
Race/ethnicity			.0001
Non-Hispanic Caucasian	306 (42)	30.5 (76)	
Hispanic/Latino	275 (38)	27.6 (69)	
Non-Hispanic African-American	26 (4)	28.2 (71)	
Asian/Pacific Islander	38 (5)	28.4 (71)	
Multiracial/other	77 (11)	29.3 (73)	
Education			.0001
Less than 8th grade	72 (10)	26.6 (67)	
8th–12th grade but no high school diploma	74 (10)	27.5 (69)	
High school diploma or general educational development	235 (23)	28.7 (72)	
Some college but no degree completed	147 (20)	29.1 (73)	
Two-year college degree/associate's degree	76 (11)	30.3 (76)	
Four-year college degree or more	118 (16)	31.3 (78)	
Primary language			.0001
English only	356 (49)	30.3 (76)	
Spanish but speaks English well	125 (17)	28.6 (72)	
Spanish but does not speak English well	170 (24)	27.1 (68)	
Other (survey performed in English)	71 (10)	28.5 (71)	
Language of survey			.0001
English	506 (70)	30.0 (75)	
Spanish	216 (30)	26.9 (67)	
Food safety training			.0001
Yes, certified managers	254 (35)	31.8 (80)	
Yes, certified nonmanagers	183 (25)	29.8 (75)	
No, noncertified food handlers	285 (40)	26.5 (66)	
Years working as a food handler			.0001
<1	35 (5)	27.4 (69)	
1–3	192 (27)	27.1 (68)	
4–6	139 (19)	28.8 (72)	
≥7	356 (49)	30.5 (76)	
Years working in current job			.0001
<1	122 (17)	28.9 (72)	
1–3	296 (41)	28.2 (71)	
4–6	150 (21)	29.3 (73)	
≥7	154 (21)	30.6 (77)	
Frequency of food handling tasks			.0001
0	30 (4)	30.2 (76)	
1	177 (25)	28.3 (71)	
2	72 (10)	29.1 (73)	
3	101 (14)	28.3 (71)	
4	99 (14)	28.4 (71)	
5	66 (9)	28.3 (71)	
6	177 (25)	30.1 (75)	

for cooking, holding and refrigeration, cross contamination, and hygiene (Table 3). Both English- and Spanish-speaking food handlers performed very poorly when asked to identify the danger zone for pathogen growth (2% vs. 0.6%, respectively). Only 17% of the food handlers identified the proper temperature to cook hamburger and 19% accurately identified the correct internal temperature to cook chicken. Only 36% of the food handlers knew that cooked rice can have germs that can make people sick, and, especially of concern, only half of the certified food managers answered this question correctly. Among the food storage questions, 68% of the English-speaking and 50% of the Spanish-speaking food handlers correctly identified that "Raw meat can be stored anywhere in a refrigerator as long as it is wrapped in plastic" as false ($p < .05$). Overall only 60% of the food handlers and 64% of the certified food managers answered correctly that raw meat should not be stored on foil-lined shelves in the refrigerator. For questions on cross contamination, 90% of the food handlers knew that ready-to-serve vegetables splashed with raw chicken juice should not be rinsed but instead must be thrown away. For the hand hygiene questions, 90% of the food handlers correctly answered false that "You do not need to wash hands thoroughly when using a spatula or tongs" or "when using single-use gloves to handle food."

Important food safety behaviors were also identified, particularly regarding working while ill. Thirty-two percent of the participants stated that they would come to work as a food handler with a sore throat and cough, 24% would come to work with an infected wound, and 17% would come to work with diarrhea. Of the 319 food handlers having had diarrhea within the past year, however, 41% (132) also stated that they were working as a food handler at that time. Nearly 10% of the food handlers in our study had been employed at a restaurant during an outbreak.

Factors Associated With the Knowledge Score

Bivariate analysis indicated that restaurant characteristics were significantly associated with the knowledge score. The mean knowledge score for small- and medium-sized restaurants was significantly but not substantially greater compared to large restaurants (74%, 74%, and 70%, respectively, $p < .05$)

TABLE **3**

Frequencies of Correct Responses to Selected Knowledge Questions Asked of Suburban Chicago Restaurant Food Handlers, Overall and by Primary Language, 2010 (*N* = 722)

Questions (Answers)	Question Type	Overall *N* = 722 (%)	English *n* = 356 (%)	Spanish *n* = 295 (%)	Other *n* = 71 (%)
Time and temperature					
Hamburger and other ground beef mixtures, such as meatloaf, should be cooked to at least what temperature on a meat thermometer? *(155°F or 160°F)*[a]	Fill-in-the-blank	124 (17.2)	73 (20.5)	43 (14.6)	8 (11.3)
Germs that make people sick grow well between which temperatures? *(40°F or 41°F to 135°F or 140°F)*[a]	Fill-in-the-blank	9 (1.3)	7 (1.9)	2 (0.6)	0 (0.0)
What is the proper minimum internal temperature to cook a chicken for at least 15 seconds? *(165°F)*	Fill-in-the-blank	139 (19.3)	73 (20.5)	55 (18.6)	11 (15.5)
Where should meat thermometers be inserted to accurately check the meat's temperature? *(The thickest part of the meat)*	Multiple choice	673 (93.2)	338 (94.9)	270 (91.5)	65 (91.5)
Food storage					
Raw meat can be stored on foil-lined shelves to prevent dripping onto other foods. *(False)*	True/false	362 (50.1)	192 (53.9)	125 (42.4)	45 (63.4)
Raw meat can be stored anywhere in a refrigerator as long as it is wrapped in plastic. *(False)*	True/false	437 (60.5)	243 (68.3)	148 (50.2)	46 (64.8)
Storing products with the earliest expiration dates in front of products with later dates is a safe food storage practice. *(True)*	True/false	544 (75.3)	313 (87.9)	183 (62.0)	48 (67.6)
Thawing food					
It is safe to put frozen chicken breast on the counter to thaw. *(False)*	True/false	589 (81.6)	302 (84.8)	234 (78.3)	53 (74.6)
Beef may be placed on the counter to defrost. *(False)*	True/false	582 (80.6)	288 (80.9)	240 (81.4)	54 (76.1)
Beef may be placed in cold water to defrost. *(True, cold running water)*	True/false	448 (62.0)	209 (58.7)	198 (67.1)	41 (57.7)
Germs					
You can be sure food is safe to eat when it smells and tastes normal. *(False)*	True/false	491 (68.0)	302 (84.8)	144 (48.8)	45 (63.4)
Raw eggs can have germs that can make people sick. *(True)*	True/false	616 (85.3)	331 (93.0)	229 (77.6)	56 (78.8)
Vegetables for a salad splashed with a few drops of raw chicken juice should not be rinsed, but instead must be thrown away. *(True)*	True/false	656 (90.9)	329 (92.4)	264 (89.5)	63 (88.7)
Eating ground meat that is not completely cooked can cause bloody diarrhea. *(True)*	True/false	510 (70.6)	215 (60.4)	238 (80.6)	56 (78.8)
Cooked rice can have germs that can make people sick. *(True)*	True/false	264 (36.6)	147 (41.3)	88 (29.8)	29 (40.8)
Hand washing					
Is it better to wet your hands with warm/hot or cold water? *(Warm/hot water)*	Multiple choice	654 (90.6)	339 (95.2)	252 (85.4)	63 (88.7)
On what should you dry your hands? *(Clean paper towel, air dryer)*	Multiple choice	638 (88.3)	316 (88.8)	260 (88.1)	62 (87.3)
And how should you turn off the water? *(Using the paper towel)*	Multiple choice	515 (71.3)	255 (71.6)	211 (71.5)	49 (69.0)
Do you need to have thoroughly washed hands if you use a spatula or tongs to handle food? *(Yes)*	Yes/no	653 (90.4)	338 (94.9)	254 (86.1)	61 (85.9)
Do you need to have thoroughly washed hands if you use single-use gloves to handle food? *(Yes)*	Yes/no	650 (90.0)	333 (93.5)	256 (86.8)	61 (85.9)
At work if you only urinated, and did not have a bowel movement, you do not need to wash your hands. *(False)*	True/false	531 (73.5)	242 (68.0)	240 (81.3)	49 (69.0)

[a]Guidance for Illinois has changed or is in the process of changing from 40°F and 140°F to 41°F and 135°F and from 155°F to 160°F for holding food and cooking temperatures.

and for restaurants serving American cuisine compared to those serving Italian and Asian cuisine (74%, 71%, and 70%, respectively, $p < .05$). The mean knowledge score for restaurants serving American cuisine was not significantly different from restaurants serving Mexican cuisine. A significant difference did not occur in score for different restaurant service styles (fast food, informal, formal) compared to each other or for chains compared to independent restaurants.

Food handler characteristics significantly associated with knowledge score were also identified. Food handlers with English primary language scored higher than those with Spanish primary language or other languages (76%, 68%, and 68%, respectively, $p < .05$). In addition, the knowledge score was higher among those who took surveys in English compared to those who took surveys in Spanish (73% vs. 68%, $p < .05$). Food handlers age

TABLE **4**

Food Handler and Restaurant Characteristics Associated With Knowledge Score, Mixed-Effects Regression Analysis (*N* = 722), 2010

Food Handler Characteristics	Multivariate Analysis	
	Estimate (Standard Error) Scale of 0–40	*p*-Value
Intercept	28.56 (0.94)	<.0001
Language		
English	Ref	
Spanish	-1.05 (0.48)	.0320
Other	-1.65 (0.54)	.0026
Age	0.05 (0.01)	.0002
Education	0.39 (0.11)	.0005
Race/ethnicity		
Non-Hispanic Caucasian	Ref	
Hispanic/Latino	-1.01 (0.48)	.0376
Non-Hispanic African-American	-1.97 (0.77)	.0113
Asian/Pacific Islander	-1.00 (0.73)	.1703
Multiracial/other	0.27 (0.53)	.6137
History of food safety training		
Yes, certified managers	Ref	
Yes, noncertified food handlers	-1.42 (0.37)	.0002
No, noncertified food handlers	-3.59 (0.35)	<.0001
Restaurant characteristics		
Restaurant cuisine		
American (no ethnic focus)	Ref	
Italian	-0.99 (0.53)	.0626
Mexican	-0.62 (0.51)	.2255
Other	-1.35 (0.57)	.0194
Restaurant size	-0.57 (0.23)	.0134
Average entrée price	0.67 (0.31)	.0316
Frequency of food handling tasks	0.29 (0.07)	.0001

40 years or older had a greater mean knowledge score compared to those in the age range of 18–29 years and 30–39 years (76%, 68%, and 73%, respectively, $p < .05$). Non-Hispanic Caucasian food handlers scored higher than those who identified themselves as Hispanic/Latino, non-Hispanic African-American, Asian/Pacific Islander, or multiracial/other race/ethnicity (76%, 68%, 70%, 66%, and 69%, respectively, $p < .05$). The score did not differ significantly by gender. Food handlers with at least some college education scored higher than those with less education (76% vs. 66%, respectively, $p < .05$). Certified food managers scored significantly higher than both certified nonmanagers and noncertified food handlers (79% vs. 75% and 65%, respectively, $p < .05$).

In the final mixed-effects regression model predicting knowledge, a significant covariance between knowledge scores of food handlers from the same restaurants was detected (random restaurant effect, $\sigma = 1.51$ [$SE = 0.57$, $p = .004$]). Food handlers whose primary language was Spanish (with or without the ability to speak English) and other language (with the ability to speak English) scored significantly lower than persons for whom English was their primary language after controlling for confounding variables (Table 4). Hispanic/Latino and non-Hispanic African-American food handlers scored significantly lower compared to non-Hispanic Caucasian food handlers (Hispanic/Latino food handlers scored about one point lower in a scale of 0 to 40, $p = .037$, and non-Hispanic African-American scored about two points lower, $p = .011$, respectively). For each additional year in age, the knowledge score increased significantly by 0.05 ($p = .0002$). An increase in education level was associated with an increase of 0.39 points in knowledge score ($p = .0005$). Certified food managers scored significantly higher compared to certified nonmanagers (about 1.42 points, $p = .0002$) and noncertified food handlers (about 3.6 points, $p = .0002$). For each additional food handling task, the knowledge score increased significantly by 0.29 ($p = .0001$). Food handlers working in smaller restaurants and those with higher priced entrées had higher knowledge scores ($p = .013$ and $p = .0312$, respectively). After controlling for other factors, no significant difference occurred in food handler scores for those working in American cuisine restaurants compared to those working in Mexican cuisine restaurants. Knowledge score was higher, however, for those working in American cuisine restaurants compared to other ethnic cuisine restaurants ($p = .019$).

Discussion

According to CDC, a reduction of foodborne illness by only 10% would keep five million Americans from getting sick each year (CDC, 2011b). It is critical to identify food safety knowledge gaps in order to guide effective educational and behavioral interventions and reduce the risk of foodborne disease. The food handlers in our study had an average knowledge score of only 72%, despite many being certified and working in this field for an average of 10 years. The knowledge gaps identified involved hygiene practices, cross contamination, and optimal temperatures for cooking, storing, and holding foods.

English-speaking and Spanish-speaking restaurant food handlers had significant differences in knowledge scores. Spanish-speaking food handlers had a lower overall mean knowledge score and scored significantly lower on questions regarding cross contamination, temperatures for holding and storing of foods, and personal hygiene. Race/ethnicity was also independently associated with knowledge. Hispanic/Latino and non-Hispanic African-American food handlers scored lower than non-Hispanic Caucasians when controlling for other factors. These differences are similar to those found in Chicago (Dworkin et al., 2011; Panchal et al., 2012). DeBess

and co-authors (2009) also reported that Hispanics had lower mean knowledge scores than non-Hispanic Caucasians. Food handler training programs are offered in various languages by the state of Illinois and nongovernmental organizations, such as ServSafe of the National Restaurant Association Educational Foundation (www.servsafe.com). Only the food safety manager, however, is required to be certified in Illinois. Cultural differences may also be important when educating specific populations and designing effective health-related training materials. Culturally tailored interventions, including storytelling, have shown promising results. For example, a recent randomized pilot study by Larkey and co-authors (2009) suggests that storytelling may be an effective approach for changing colorectal cancer risk-related behavioral intentions among Latina women. In addition, Utz and co-authors (2008) have shown that a culturally tailored storytelling approach is well received by rural African-Americans with type 2 diabetes. A need exists to create effective educational interventions that are both linguistically and culturally appropriate in order to remedy knowledge gaps and disparities among restaurant food handlers.

Although certified food managers scored significantly higher than noncertified food handlers, their mean knowledge score was only 79%. Currently, the Illinois Department of Public Health and nongovernmental organizations require food handlers to score at least 75% to pass the certification exam. The Illinois state certification exam tests the following food categories: foodborne illness, food protection, hazards and time/temperature relationships, facility sanitation and cleaning, personal hygiene and food safety, and food safety management (Illinois Department of Public Health, 2011). Other topics such as rodent control and facility maintenance are addressed; however, it is unusual to find foodborne illness outbreaks directly linked to these topics as opposed to problems with hand hygiene or cross contamination (Todd et al., 2007). We are not aware of any studies that determine the optimal minimum score on a certification exam to ensure maximum food safety knowledge. Adequately trained and knowledgeable certified food managers should teach food safety knowledge and behavior to the restaurant staff. The Illinois Food Service Sanitation Code, however, does not explicitly require this of certified food managers (Illinois Administrative Code, 2008). Therefore, it is at the discretion of each restaurant to determine how to train the staff in food safety.

Many factors can make food safety training challenging. Inadequate or lack of training materials may be one such factor. For example, food safety educational materials may be inconvenient or costly to obtain. In addition, language barriers between certified managers and their food handling staff may make training difficult. A certified food manager who only speaks English with a Spanish-speaking staff may have trouble clearly conveying important food safety messages. Also, the baseline knowledge of the certified managers may not be optimal if initial food safety knowledge was incomplete or information has been forgotten. This is especially of concern since certified managers missed one of five questions on our survey, which may compromise their ability to adequately train the restaurant staff. On top of all of these factors, it may be difficult for the busiest restaurants to find time to train their staff in food safety, even if it is considered to be important.

In our study, questions about the range of the temperature danger zone at which pathogens proliferate and the internal cooking temperatures of hamburger and chicken were answered correctly by fewer than one-third of the certified food managers. Similarly poor results were found in Chicago and Oregon (DeBess et al., 2009; Dworkin et al., 2011; Panchal et al., 2012). Currently, certified food managers in Illinois are required to renew their certification after five years, which is a lengthy time to retain knowledge. In fact, certified food managers can elect to sit passively in a five-hour refresher course instead of retaking the exam (Illinois Administrative Code, 2008). A need exists to reconsider the minimum certification requirements to ensure high levels of food safety knowledge among food handlers, to prevent food poisoning among restaurant patrons, and to keep restaurants from expensive and disastrous public health events.

It is important to note that even with highly knowledgeable staff, adequate behavior compliance may not occur. Although Clayton and co-authors found that food handlers were aware of recommended food safety practices, two-thirds reported not always exhibiting these behaviors (Clayton, Griffith, Price, & Peters, 2002). Food handlers who work while ill are a challenging food safety issue for restaurants (Jones & Angulo, 2006). Our study showed that a substantial proportion of the food handlers would come to work with a respiratory infection, diarrhea, or an infected wound (32%, 17%, and 24%, respectively). Future research should further evaluate the disconnect between food safety knowledge and safe food handling behaviors.

The absence of adequate food safety knowledge and environmental and cultural factors (for example, restaurant manager food safety leadership) are likely precursors to poor food handling behavior (Yiannas, 2008). Hygiene knowledge and behavior are poor among restaurant food handlers and have contributed to a large number of foodborne illness outbreaks (Angelillo, Viggiani, Rizzo, & Bianco, 2000; Clayton et al., 2002; Cody & Hogue, 2003; Pragle, Harding, & Mack, 2007; Shapiro et al., 1999). We suspect one reason for poor hygiene and food safety compliance may be that food handlers do not fully appreciate the harmful consequences that can result. Signage encouraging proper hand washing may not sufficiently illustrate that people can die from food safety behavior malpractice, so it may be helpful for food handlers to understand alarming outcomes of foodborne illness (including vomiting, bloody diarrhea, and death). Our study demonstrated that 71% of food handlers understood that eating improperly cooked ground meat can cause bloody diarrhea and hand hygiene knowledge was relatively high in this population. Fifteen percent of participants, however, found it acceptable to turn off the water with washed bare hands, which may be too high a proportion given the importance of hand washing. Food safety and hand hygiene training is an important first step that should be followed by monitoring behavioral compliance.

Strengths of our study included review of the survey tool by public health departments and the University of Illinois at Chicago Survey Research Laboratory, administration of the survey by trained interviewers rather than requiring participants to read, and offering the survey in English and Spanish. While a sample size of 729 food handlers is large, our study may not be representative of all restaurants and food handlers in suburban Chicago. The restaurant participa-

tion rate for this study was only 32%, which may limit generalizability. The participating restaurants and food handler characteristics may differ between counties. This is unlikely, however, as the 2010 U.S. census data demonstrate similar demographic characteristics for those living in the suburbs surrounding Chicago (U.S. Census Bureau, 2011). Participation bias may have led to an overestimation of knowledge scores if more knowledgeable food handlers were more likely to participate.

Conclusion

The data from our survey demonstrate substantial and important food safety knowledge gaps among suburban Chicago restaurant food handlers that can place restaurant patrons at increased risk of food poisoning. The investigators are currently using educational materials in two learning formats (a brochure and comic book) that utilize the food safety topics prioritized by the knowledge survey and will determine if one of these formats more effectively educates food handlers about food safety. Furthermore, the investigators are performing analysis to determine if restaurant food handler knowledge gaps predict violations identified during restaurant inspections.

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Can Realtor Education Reduce Lead Exposures for Vulnerable Populations?

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Abstract **Lead is known for its devastating effects on people, particularly children under the age of six. Disturbed lead paint in homes is the most common source of lead poisoning of children. Preventive approaches including consumer education on the demand side of the housing market (purchasers and renters of housing units) and disclosure regulations on supply side of the housing market (landlords, homeowners, developers, and licensed realtors) have had mixed outcomes. The study described in this article considered whether a novel supply-side intervention that educates licensed real estate agents about the specific dangers of lead poisoning would result in better knowledge of lead hazards and improved behavior with respect to the information they convey to potential home buyers. Ninety-one licensed realtors were trained for four hours on lead hazards and their health impacts. Pre- and postsurveys and a six-month follow-up interview were conducted to assess the impact of the intervention on their knowledge and self-reported behaviors with clients. The findings suggest that supply-side education could have a salutary impact on realtor knowledge and behavior.**

Introduction

Lead is the number-one environmental health hazard for children in the U.S. (U.S. Environmental Protection Agency [U.S. EPA], 2010a). In a major policy address, Satcher (2000) encouraged the nation to address this problem, stating that "reducing lead exposure not only benefits children's health and development but also yields economic benefits from avoiding health care and special education costs, from preventing reductions in children's intelligence, academic achievement, and future productivity, and from improvements to housing associated with controlling lead hazards."

Our study sought to determine if a supply-side intervention that educates licensed real estate agents about the specific dangers of lead poisoning in residential structures would lead to improvements in their knowledge, attitude, and behaviors with respect to the hazards of lead paint. Would such an intervention lead to more detailed and timely information on lead hazards to potential home buyers, especially those with particularly vulnerable members (i.e., young children and pregnant women)?

The District of Columbia includes high-risk neighborhoods. Screening data for the district in 2004 showed that Wards 1, 4, 5, and 6 had the highest prevalence rates. Of the more than 21,000 children under the age of six living in these wards, 32% were tested for lead poisoning; of these, 14% had elevated blood lead levels of 10 µg/dL or higher. This rate is twice that for the district as a whole (Onwuche, 2005). Of the 14,024 housing units in these wards that were constructed between 1950 and 1978, over 90% have undergone repairs or renovations. Many of these units have increased potential for lead hazards since many renovation contractors and do-it-yourselfers fail to use lead-safe work practices. The high incidence of elevated blood lead levels in these wards may be partly explained by the fact that a substantial percentage of lead poisonings in children occur in recently renovated housing. The Centers for Disease Control and Prevention (CDC) reported that in New York State, 14% of children with blood lead levels over 20 µg/dL most likely were exposed to lead through home renovation, repair, and painting activities, while 40% of those with significant exposure levels below 20 µg/dL were exposed to lead in the same way (CDC, 2009). In the District of Columbia, about 75% of the houses in the wards of interest were built before 1978, making them likely to harbor lead-based paint. The District of Columbia thus represents an important front in the fight against childhood lead poisoning.

Background

Lead, once called a "gift of God" (Rosner & Markowitz, 1985) is found in its natural state all over the world and is "virtually indestructible, is non-biodegradable, and has been known since antiquity for its adaptability in making various useful items (U.S. EPA, 2010b)." Lead has been found to be very harmful to children, however, particularly those under the age of

six. Even low levels of exposure to lead can result in IQ deficits, learning disabilities, behavioral problems, stunted or slowed growth, and impaired hearing (Lustberg & Silbergeld, 2002; Satcher, 2000; U.S. EPA, 2010a). Jacobs and co-authors (2002) found that although some decrease had occurred in the number of units with lead paint during the 1990s, lead paint hazards still remain in 25% of all U.S. housing.

Many approaches to reducing lead exposures have been implemented since the 1978 ban on lead paint (CDC, 2000, 2007; Mushak & Crocetti, 1990). Secondary measures have been mandated by government, including requirements for blood tests for at-risk children (e.g., the Childhood Lead Poisoning Screening and Reporting Emergency Act of 2002, effective June 3, 2002 [D.C. Act 14-379; 49 DCR 5301]). Childhood lead poisoning prevention advocates have increasingly stressed the importance of primary prevention measures (e.g., District of Columbia [2008], the Lead-Hazard Prevention and Elimination Act of 2008). Making homes lead safe, ranging from full abatement to window replacement to fully covering old paint, has been supported by many U.S. Department of Housing and Urban Development (HUD) programs; educating housing consumers in both rental and owned properties has also been a major "demand side" initiative (Lanphear, Hornung, & Ho, 2005; National Center for Healthy Housing, 2006). On the supply side of the housing market, government has taken the general approach of implementing regulations and associated penalties for violation rather than educating about the hazards created by lead paint, since in a market economy housing suppliers have financial incentives to downplay any defects or hazards in the properties they sell or rent. All of these approaches to reducing lead exposures have been helpful, but adding educational programming about lead hazards on the supply side of the market (landlords, homeowners, developers, and licensed realtors) might add another weapon to society's arsenal in the war against childhood lead poisoning.

Abatement

The total removal of lead paint from old housing in the U.S. has long been rejected by authorities as too expensive (Schelenker, Baxmann, McAvoy, Bartkowski, & Murphy, 2001). Chisholm (2001) noted the importance of reducing environmental exposure primarily by monitoring and remediating housing based on dust lead levels, not children's blood lead levels.

Demand Side Educational Programming

Hilts and co-authors (1998) studied the effectiveness of interventions on children's blood lead levels in Trail, Canada, the site of an active lead/zinc smelter. Their findings indicated that education and dust control, particularly targeted toward high-risk children, appear to have served as effective and appropriate interim remedial measures. A team-based approach to prevention is also often cited by both researchers and policy makers alike as another method of reducing childhood lead poisoning. Chisholm (2001) states that such teams should include physicians, public health nurses, social service workers, and environmental inspectors, noting that "poor residents in dilapidated housing, armed with mops and buckets, are not able to do and maintain a satisfactory cleanup."

Goldman (1997) advocated for education on the demand side of the housing market—specifically parents—as a primary method of preventing childhood lead poisoning. Building on insights from Goldman (1997) and Binns and co-authors (2007), the Howard University Center for Urban Progress created an interactive database containing the lead status of housing in the District of Columbia as an educational tool (Green & Phoenix, 2008). Other localities have implemented interactive Web sites (e.g., www.njleadsafe.info/ and dhs.wisconsin.gov/lead/maps/index.htm). Green and Phoenix (2007) addressed the problem of childhood lead poisoning by using a community-based participatory approach, which included local government agencies, faith-based organizations, and the broader community, demonstrating some modest progress. Schelenker and co-authors (2001) concluded that community-based outreach and partnership approach could also help. Rajaram (2007), however, found that community outreach centers often fail due to lack of resources. Other studies found such initiatives to be inadequate or to yield no positive impact (Dugbatey, Croskey, Evans, Narayan, & Osamudiamen, 2005; Jordan, Yust, Robinson, Hannan, & Deinard, 2003).

Regulatory Action on the Supply Side

Federal regulations require that sellers must disclose the lead content of any home constructed prior to 1978 before it is sold, rented, or refinanced (Shannon, 1994). Numerous studies point to the nontrivial costs as well as benefits of regulation (Baldwin, 2004; Braithwaite, 2002; Coglianese & Lazer, 2003; Daley, Haider-Markel, & Whitford, 2007; Kagan, Thornton, & Gunningham, 2003). Landlords and property managers have been faced with lawsuits and real estate agencies have had to pay millions in fines (Weissman, 2006; Zeldes, 1998). In their study on the federal role in the prevention initiatives for children, Ripple and Zigler (2003) asserted that population data have shown that dramatic decreases have occurred in the incidence of lead poisoning cases associated with the passage of federal legislation, as seen in decreases in national average blood lead levels among children.

Yet loopholes remain (Mitka, 2008). Weissman (2006) argues that "one common way realtors fail to comply with federal law is by attaching the Seller's Property Disclosure Statement (containing the lead-based paint disclosures) to the contract after the contract is signed by the parties. When this is done, the buyer is making the decision to purchase first and receiving the lead-based paint disclosures second. This is putting the cart before the horse, since federal law requires that just the opposite be done." A market system generates incentives for such harmful actions and is an example of the market's inability to solve such problems without government intervention. Yet educational intervention at the level of the individual realtor may still yield some modest amelioration of this market failure.

Research Question

Can a supply-side intervention that educates licensed real estate agents about the specific dangers of lead poisoning result in better knowledge of lead hazards and improved behavior with respect to the information they convey to potential home buyers?

Hypotheses

Hypothesis 1: Licensed real estate agents who receive structured training on lead hazards, health effects of lead exposure on children and adults, and lead-safe work practices will increase their knowledge of lead hazards as measured by positive changes from pre- to postsurvey answers on knowledge questions

and will report an increase in their intention to provide guidance to prospective home buyers immediately post training as measured by positive changes from pre- to postsurvey answers on behavior-related questions.

Hypothesis 2: Licensed real estate agents who receive structured training on lead hazards, health effects of lead exposure on children and adults, and lead-safe work practices will demonstrate that they retain knowledge of lead hazards and report that they have improved guidance to prospective home buyers six months after training.

Methods

A combination of quantitative and qualitative techniques was used to assess the validity of these hypotheses.

The Sample

The research team secured the cooperation of managers of local realty firms who provided lists of prospective participants for the demonstration project from the realtors on their staffs. The research team contacted these prospects by telephone and followed up with written descriptions of the activity. Some of the realty firms also assisted in the recruitment outreach process by posting the information in their newsletters or announcing the availability of training at staff meetings. Since the research team had been approved as a certified trainer by District of Columbia government, it was able to conduct additional recruitment by posting information about the training on a District of Columbia government Web site with access limited to licensed realtors.

The team conducted the training sessions on a rolling basis. Recruitment for a session began a few weeks before a scheduled training session and registration forms were collected by fax. The sessions were held in spaces arranged by the faith-based partners in this project. Institutional review board–approved consent forms were presented to the participants and their agreement secured. A financial incentive of $200 was given to all licensed realtors who participated.

Ninety-one licensed real estate agents participated in this training. Realtors completed pre- and postsurveys on the day of the training. Follow-up surveys were mailed or e-mailed to participants six months after the training. Telephone follow-up calls were made to those who did not return the surveys. Significant attrition of the sample occurred over the six-month period due in large measure to volatility in the staff of real estate offices during the early stages of the mortgage crisis of 2007–2008. Some realtors were no longer actively selling homes and some had changed employment and could not be tracked. Other realtors who were contacted by telephone declined to respond to the survey questions for unknown reasons.

The Intervention

Lead-safe work practices training for licensed real estate agents was held on six occasions between April 2007 and December 2007. Each training session lasted four hours. The training included HUD's standard lead-safe work practices curriculum, augmented by a film demonstrating safe cleaning techniques and a hands-on demonstration of the two-bucket cleaning system. This system uses clean rinse water so that the mop that is used to clean does not spread lead dust over surfaces that have already been cleaned. The training also used a mock-up dwelling to illustrate the places in the home where lead dust can accumulate.

Part one of the training included presentations on the health effects of lead and mechanisms of exposure for children and pregnant women as well as likely places to find lead in the home. The next training component was provided under the assumption that the realtors had no previous training in lead-safe methods of maintenance or renovation work on older, presumably lead-contaminated, housing. These training modules equipped participants with skills they could use and share to alter work practices of both their clients and themselves to minimize dust generation, disturb as few lead-painted surfaces as possible, and clean up any lead dust generated in the process. Trainees received a practical demonstration of cleaning techniques and placement of dust barriers.

The Instrumentation and Its Implementation

Identical pre- and postsurveys were completed immediately before and after the training that included nine objective questions (two related to knowledge and seven related to their behavior with clients) and four open-ended questions to elicit commentary about their knowledge of lead hazards and their attitude towards discussing these hazards with clients.

Six months after training, a telephone survey of participants was conducted using a structured interview schedule that asked for information about sales over the past six months and open-ended questions about realtor behavior with clients.

The pre- and postsurveys given before and immediately after training were intended to test Hypothesis 1 and assess the immediate impact of the intervention on both the change in knowledge of the realtors and the change in their attitude towards discussing lead hazards with clients in the future. The follow-up survey was intended to test Hypothesis 2 to determine if realtors retained lead hazard knowledge and reported behavior that reflected a higher awareness of lead hazards both on their part and on the part of their clients.

Results

Hypothesis 1

Licensed real estate agents who receive structured training on lead hazards, health effects of lead exposure on children and adults, and lead-safe work practices will increase their knowledge of lead hazards as measured by positive changes from pre- to postsurvey answers on knowledge questions and will report an increase in their intention to provide guidance to prospective home buyers immediately post training as measured by positive changes from pre- to postsurvey answers on behavior-related questions.

Statistical Findings From the Pre- and Postsurveys

Seven paired questions were on the pre- and postsurveys. A nonparametric related-samples McNemar test was used to determine if the distribution between "yes" and "no" to each question changed from pre- to postsurvey. The null hypothesis for each question was no change occurred in the distribution of "yes" and "no" answers to the question from pre- to postsurvey (Table 1). For the first question, "Do you distribute the disclosure pamphlets on lead poisoning to clients during real estate transactions?", no test could be implemented because 100% of the sample responded "yes" on both pre- and postsurveys. From simple observation, the null hypothesis could not be rejected. For the second question, "Have any of your clients requested a lead inspection?", the percentage of "yes" responses rose from 24.2% at presurvey

TABLE **1**

Pre- and Postsurvey Results of Realtors: Frequencies, Percentages, and Significance (*N* = 67)

Question	Pretest *n*, Frequency "Yes"	%[a]	Posttest *n*, Frequency "Yes"	%	Significance[b]
Do you distribute the disclosure pamphlets on lead poisoning to clients during real estate transactions?	66	100.0	67	100.0	–[c]
Have any of your clients requested a lead inspection?	16	24.2	19	28.4	.000**
Would you be more inclined to recommend a lead inspection to clients who have or are expecting young children?	53	86.9	64	95.5	.004**
Have you ever emphasized the inspection option to one of your clients?	29	48.3	31	47.0	.250
Do you mention the age of housing to your clients?	62	95.4	67	100.0	.250
Are you aware of the date lead paint stopped being used in residential paint?	54	96.4	65	98.5	.500
Would you encourage clients who have young children to test their homes for lead?	46	88.5	64	97.0	.031*

*$p \leq .05$.
**$p \leq .01$.
[a]Missing values are excluded from percentage calculations.
[b]Nonparametric related-samples McNemar Test.
[c]Test cannot be conducted due to lack of variation in responses (100% yes).

to 28.4% at postsurvey ($p = .000$) and the null hypothesis was rejected. For the third question, "Would you be more inclined to recommend a lead inspection to clients who have or are expecting young children?", the percentage responding "yes" rose significantly from presurvey to postsurvey from 86.9% to 95.5% ($p = .004$). For the fourth question, "Have you ever emphasized the inspection option to one of your clients?", the change in percentage of "yes" responses from 48.3% to 47% was not significant ($p = .250$) and the null hypothesis could not be rejected. For the fifth question, "Do you mention the age of housing to your clients?", a similar finding occurred ($p = .250$) and the null hypothesis could not be rejected. For the sixth question, "Are you aware of the date lead paint stopped being used in residential paint?", once again the null hypothesis could not be rejected ($p = .500$). For the seventh question, "Would you encourage clients who have young children to test their homes for lead?", the percentage of "yes" responses rose significantly from 88.5% to 97.0% ($p = .031$).

Discussion of the Statistical Findings From the Pre- to Postsurveys

Real estate agents were generally aware that lead in older homes posed a problem before the training since 100% of those who answered the first question stated they did, in fact, distribute the required disclosure pamphlets. High percentages of the realtors generally indicated knowledge about lead during the presurvey, with over 96% stating that they knew the date that lead paint had been banned in residences. After training, the responses suggested an even greater awareness of the challenges of lead.

Significant changes also occurred in responses to the questions about planned behavior. Realtors signaled that they "would . . . be more inclined to recommend a lead inspection to clients who have or are expecting young children" and that they "would . . . encourage clients who have young children to test their homes for lead" at a greater frequency after training, indicating that the training had had the desired effect of changing the planned behavior of the realtors.

Qualitative Findings and Discussion

In response to the query, "What are the effects of lead on young children?", realtors showed some knowledge about lead effects on children at presurvey, but they gave answers with greater sophistication and depth at postsurvey (Table 2).

At presurvey, many realtors wrote responses concerning brain damage and mental development. Their responses included generally correct, if often unsophisticated, statements such as "could cause brain damage, kidney damage" and "slow mental development." Some agents demonstrated less knowledge at presurvey, simply writing "serious" or "if eaten, they [lead paint chips] can be dangerous to young children's health," while some agents knew little or nothing (e.g., "not sure—know it's toxic to them" and "I don't know"). In some cases, realtors gave inaccurate responses, indicating that lung/breathing problems and asthma triggers were effects of lead on young children.

At postsurvey, a higher degree of sophistication in answers to this question emerged, reflected in the fact that the total number of words used by all respondents who responded to both pre- and postquestion was 30% greater at postsurvey than at presurvey (391 words versus 300 words). Sentences were longer and more thoughtful, reflecting greater comprehension and more detailed knowledge of the subject.

The finding of qualitative improvement in knowledge immediately post training combined with the finding that the realtors intended to change their behavior after training supports Hypothesis 1.

Hypothesis 2

Licensed real estate agents who receive structured training on lead hazards, health

TABLE **2**

Selected Responses to Knowledge Questions About Lead Impacts on Health

Pretest	Posttest
Could cause brain damage, kidney damage	[Causes] potential brain damage, hyperactivity, muscle or joint aches, attention deficit hyperactivity disorder (ADHD), death
Brain damage	[Causes] neurological disorders, attention deficit disorder (ADD), lower level of achievement
Harmful to developing brains	Affect[s] health—nervous system development can cause learning disabilities, ADD/ADHD, can cause seizures, coma and death at severely high levels
Slow mental development	[Causes] joint disease, decreased learning capacity, ADD, coma and sometimes death
Mental disabilities	[Causes] brain damage, learning disabilities (all permanent)
Delayed brain development, learning disabilities	[Is] toxic—poisoning to system, attention deficit, growth deficiency
Negative effects on neurological development	[Leads to] lifelong issues—neurological and other health problems
It causes damage to their nerve system	[Causes] brain damage, [affects] bone building, [causes] lethargic acting, slow develop[ment] mentally
It affects their development; it affects their IQ levels…lots of issues	Affects all systems (body organs) and causes all types of health problems
Brain damage, retardation	Affects development; body absorbs it and uses it as calcium; it affects their behavior and IQ
Death, severe illness	Damages their nerve system and kidneys, it will affect their learning abilities, it hurts their digestive system
Apathy/slow learning/lack of attention	
Possible long-term organic and brain damage	
Nervous system and brain development possibly leading to learning disabilities, language development, ADD/ADHD	
Mental and motor disorders, ADD, coma at high levels	
Make elevated levels of lead in the blood supply, which can make them act as mentally challenged and nonresponsive	
Serious	
If eaten, they can be dangerous to young children's health	
Inhaling or eating lead dust from old window sills…dangerous for small children	
Not sure; know it's toxic to them	
I don't know	
Birth defects	
Lung/breathing problems	
Asthma triggers	

effects of lead exposure on children and adults, and lead-safe work practices will demonstrate that they retain knowledge of lead hazards and report that they have improved guidance to prospective home buyers six months after training.

Findings

The realtors interviewed in the follow-up period brokered a substantial number of sales in the six months after training. The total number of home sales by 18 respondents was 59, of which 47 were pre-1978 homes. Therefore, adequate practical experience occurred in real estate transactions among the members of the sample to assess the persistence of knowledge improvements and whether changes in behavior had occurred.

The answers to qualitative questions in the telephone survey included three principal themes: "Changes in disclosure methods with clients"; "Changes in providing information to clients about lead-safe work practices when repairing/remodeling"; and "Changes in realtors' personal lives as a result of their increased knowledge about lead."

Changes in Disclosure Methods With Clients

Nine (56.3%) realtors reported that they had changed the disclosure method they use with clients and that they changed their ideas about repairing/remodeling housing units (Table 3). One respondent told the interviewer, "Before I used to have them read and sign. Now I go back to [get] questions and to emphasize." Another said, "[I now] explain the Lead Paint Disclosure completely before asking buyers to initial and sign [and] [r]eview pages of the [U.S.] E[nvironmental] P[rotection] A[gency] document and highlight protection measures when 'at-risk' occupants will reside in the property."

Changes in Providing Lead-Safe Information to Clients

Several realtors responded positively to the question about the way they think about repairs and remodeling in terms of their clients

TABLE **3**

Changes in Disclosure Methods as a Result of the Class: Selected Responses

"[I now] explain the Lead Paint Disclosure completely before asking buyers to initial and sign [and] [r]eview pages of the [U.S.] E[nvironmental] P[rotection] A[gency] document and highlight protection measures when 'at-risk' occupants will reside in the property."
"[I go] into more detail on the effects and how they [a]ffect children."
"I make sure that the client has all of the information I received. Especially if they have children."
"Yes, I have people think about it. I stress the importance."
"I express to them the importance of having it removed or properly covered."
"A family that I spoke to has 20-month-old twins and I will be informing them of all the issues about lead."
"Before I used to have them read and sign. Now I go back to [get] questions and to emphasize."
"Be careful with regard to children. A couple in DC bought an old house. The [w]oman was pregnant and the home had to be stripped of all paint because [the] woman had [a] very high level of lead in her blood. The [h]ome [had to be] vacated nine months before it could be restored."
"[I now know] how deadly lead paint is and how important it is to inform my clients about repairs—lead-based paint and construction, especially while occupying the property."

TABLE **4**

Changes in How Participants Think About Repairs/Remodels in Terms of Clients: Selected Responses

"[I h]ighlight protections whenever modifications [are to be] made by occupant, including installing window-size A/C and moving wooden/painted window up or down. [I tell them to] watch for flaking plaster and paint [and] encourage them [to] repair and encapsulate with proper protection to themselves."
"I strongly encourage clients with kids to have any major remodeling done before moving in if possible."
"[I urge clients to] minimize dust particles and disposal."
" [A client d]oes not grow any herbs in her backyard anymore."

TABLE **5**

Changes in Personal Life as a Result of Training: Selected Responses

"Definitely—[the training was an] eye opener—I informed my daughter and son-in-law about issues regarding lead."
"I [now] always ventilate properly, wash my hands after cleaning, and wear gloves as often as possible."
"I asked my own contractor to use lead safety products." "[Everyone should] just . . . be more aware of how toxic the environment can be when using household chemical[s]."
"I am now more aware of toxic possibilities."
"[I] chemically removed paint from doors rather than using a heat gun [in my 1927 home]."
"Not really, because my home is newer and I don't do repair[s]."
"No, however, I feel that the class gave me greater insight on the negatives of having lead paint present in one's environment."

(Table 4). One respondent told the surveyor, for example, that "[I h]ighlight protections whenever modifications [are to be] made by occupant, including installing window-size A/C and moving wooden/painted window up or down. [I tell them to] watch for flaking plaster and paint [and] encourage them [to] repair and encapsulate with proper protection to themselves." Another noted that "I strongly encourage clients with kids to have any major remodeling done before moving in if possible."

Changes in Their Personal Lives as a Result of Their Increased Knowledge About Lead

When asked about changes in their personal lives as a result of the training, realtors frequently responded positively (Table 5). One realtor said, "Definitely—[the training was an] eye opener—I informed my daughter and son-in-law about issues regarding lead." Another said, "[I] chemically removed paint from doors rather than using a heat gun [in my 1927 home]."

Discussion

The analysis of pre- and postsurvey results indicated that the training had a positive effect on the knowledge of realtors about the dangers of lead poisoning from residential sources, especially paint in homes built before 1978. The realtors had a basic knowledge of lead hazards prior to the training most likely due to the regulatory disclosure requirements for real estate transactions. The severity of the harm done by lead, however, had not been fully internalized by realtors, reflected in their rather superficial responses to the presurvey prior to the training. It appears that this enhanced knowledge strengthened, immediately post survey, the stated intentions of realtors to provide more information about lead hazards to clients.

The six-month follow-up interviews indicated that some realtors maintained their knowledge and had, in fact, changed their behaviors as a result of the training. This finding is supported by the fact that over half of the responding realtors said that they had changed their disclosure procedures, and is further supported by the quality of statements made by them, ranging from an emotional affirmation of change to a detailed discussion of specifically how they had implemented a

careful discussion of lead dangers and hazard reduction techniques with a number of their clients. The reported changes in their personal lives indicate that their knowledge increase had been maintained and internalized and would therefore be likely to have a lasting effect on their behavior as licensed real estate agents. These findings modestly support Hypothesis 2.

Limitations and Opportunities for Future Research

The results of this experiment should be considered suggestive rather than definitive for several reasons that future researchers could address. The sample was not necessarily representative of the universe of District of Columbia realtors. It was small; the 91 realtors out of an underlying population of 13,298 licensed real estate agents in 2007 in the District of Columbia accounted for only 0.6% of the realtor population (District of Columbia Occupational and Professional Licensing Boards and Commissions, 2008). Moreover, these realtors volunteered to participate in the training; they were not selected randomly. It is therefore difficult to assess the sample's representativeness of the underlying population. One the one hand, it is possible that a selection effect occurred; volunteers may have already been inclined towards greater concern for clients than the typical realtor. On the other hand, the generous stipend for participation ($200 each) may have been the primary motivation of most participants without regard to their initial attitudes towards their clients.

A further concern about the findings is that, even among the participants, significant incompletion occurred on pre- and postsurveys by some participating realtors (approximately 26% of the participants did not complete pre- and postsurveys). Moreover, only a minority of the sample could be interviewed at the six-month follow-up telephone interview. The distribution of knowledge and behavioral changes among those who did not complete the pre- and postsurveys or those who were not available for the follow-up telephone survey is unknown.

Knowledge retention and behavioral change were assessed over the relatively short period of six months. Future research could probe the longer-term impacts of such knowledge and behavioral change. While knowledge is likely to be retained, behavioral change could be affected by possible financial impacts that would not be obvious in six months. If agents were to find, for example, that their sales of pre-1978 housing declined because of more attentive disclosure practices, they might adopt less forthcoming approaches despite their greater knowledge of lead hazards.

The training course used in our study was a slightly modified version of a classroom-based standard half-day lead-safe work practices curriculum. For the realtor, participating in the training required giving up almost a day of activity, and hence required a substantial stipend. Other training strategies could be examined as well, including online courses and shorter courses that would less be costly. While the classroom-based courses provide hands-on work with equipment and physical examples of lead hazards that cannot be easily replicated in a short course or an online course, they may still be effective in changing the knowledge and behavior of realtors. Future research might compare, on a cost-benefit basis, alternative training strategies in terms of their outcomes for knowledge and behavior of agents.

Our study did not measure the impact of changes in the realtor on the welfare of the clients. It was assumed that higher knowledge levels and improved self-reported behavior on the part of the realtors would, in fact, have a beneficial effect on the client, but this was not measured. Surveys of clients of realtors who undergo lead-safe work practices training would be a reasonable next step in this research area to evaluate such possible client outcomes.

Conclusion

Childhood lead poisoning remains a serious health problem for children in the U.S. even though lead paint has been outlawed since 1978. Various preventive approaches have been taken to address the problem, largely in the form of educational programming on the demand side of the housing market and regulation on the supply side. These approaches have had mixed outcomes. Our study found that a supply side, nonregulatory, educational intervention with real estate agents may well result in better realtor knowledge of lead hazards and improved realtor behavior with respect to lead hazard information conveyed to potential home buyers.

The dearth of supply side educational efforts reported in the literature is most likely due to the belief that day-to-day market incentives militate against agents providing information that might discourage a particular potential buyer from executing a purchase. Since agents typically represent sellers, they and their clients are motivated financially to minimize any defects or challenges in their properties. The conventional wisdom has been that only direct regulation, as reflected in disclosure laws, could offset these financial incentives with potential financial/legal disincentives and penalties. And yet, realtors are not only market actors but also complex human beings. The evidence in our study suggests that fuller knowledge about lead hazards on the part of real estate agents could influence their willingness to act with greater concern for the client's welfare with regard to lead hazards. In the fight against childhood lead poisoning, implementing educational initiatives for realtors may prove to have significant benefits.

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Did You Know?

The NEHA 2014 Annual Educational Conference (AEC) & Exhibition will take place July 7–10, 2014, in Las Vegas, Nevada, at the Cosmopolitan Hotel. The event will be held in conjunction with the International Federation of Environmental Health's 13th World Congress. Stay tuned to neha2014aec.org for more information.


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Self-Reported Bed Bug Infestation Among New York City Residents: Prevalence and Risk Factors

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Abstract **Bed bug infestations have risen precipitously in urban areas. Little is known about risk factors for infestations or health outcomes resulting from these infestations. In the 2009 Community Health Survey, which is a representative population-based survey, 9,934 noninstitutionalized adults in New York City reported on bed bug infestations requiring an exterminator in the past year. The authors estimated infestation prevalence and explored predictors of infestation and associations between infestations and health outcomes using logistic regression. Seven percent of adults in New York City reported bed bug infestations. Significant individual and household risk factors were younger age, increased household poverty, and having three or more adults in the household. Environmental risk factors included living in high poverty neighborhoods and in buildings with more housing units, suggesting apartment-to-apartment transmission. Bed bug infestations were not associated with stress-related outcomes of alcohol consumption or recent depression, and, unlike cockroach infestation, were not associated with recent asthma episodes caused by allergens or contaminants.**

Introduction

Bed bug infestations virtually disappeared in industrialized countries after World War II. In the past decade, however, urban centers around the world have seen double-digit increases in reported infestations (Boase, 2008; Doggett & Russell, 2008). In the U.S., measurement of infestation across geographic areas has not been systematic; estimates are frequently generated from housing complaints and municipal control efforts. To date, New York City has reported higher infestation levels, with data from the city's telephone complaint line indicating a sharp increase in the past decade, from 537 in 2003 to 1,839 in 2004 to 10,985 in 2009 (Centers for Disease Control and Prevention [CDC], 2011). These reports are unverified and interpretation of estimates remains challenging.

Little is known about risk factors for bed bug infestation. Bed bug transmission has largely been assumed to happen via "hitchhiking"—when bed bugs sequester themselves on clothing or personal items and travel with new hosts who have visited infested places or acquire infested furniture, clothing, or toys (Wang, Saltzmann, Chin, Bennett, & Gibb, 2010). Historically, research has suggested that building characteristics may present higher risk for other infestations; for example, low-income households are at greater risk for mice or cockroach infestations, possibly due to overcrowding and poor housing stock, with implied inferior building management (Rauh, Chew, & Garfinkel, 2002). More recently, field reports from one study proposed apartment-to-apartment bed bug travel via structural egress points such as hallways or electrical conduit (Wang et al., 2010).

The physical health impact of the apparent rise in infestations has yet to be determined. Known health effects of bed bugs are primarily limited to rare cases of anaphylactic shock (Goddard & deShazo, 2009; Parsons, 1955) and more common dermatological bite reactions of blisters and rashes (Mazzotti et al., 2003; Sampogna et al., 2004). Bites can itch, which may lead to secondary infection from scratching (Delaunay et al., 2011). Unlike cockroach allergens (Wang, Abou El-Nour, & Bennett, 2008), the limited studies examining possible associations between bed bug infestation and asthma onset or exacerbations are inconclusive (Abou Gamra, el Shayed, Morsy, Hussein, & Shehata, 1991). Bed bugs are unlikely to transmit infectious diseases (Jupp, Purcell, Phillips, Shapiro, & Gerin, 1991; Vaughan & Azad, 1993; Webb et al., 1989). Hepatitis B is a possible exception (Delaunay et al., 2011) with a second recent hypothesis that bed bugs could serve as a reservoir for methicillin-resistant *Staphylococcus aureus* (Lowe & Romney, 2011). Since the bed bug resurgence, studies on prevalence of dermatological presentations and vector competency for transmitting infectious diseases have dominated research on health outcomes.

Bed bug infestations probably cause mental stress, with largely unknown consequences. One study found that among 474 households with confirmed cases of bed bugs, some resi-

dents reported mental health symptoms in relation to infestations, including sleeplessness (29%), anxiety (20%), emotional distress (22%), and stress (14%) (Potter et al., 2010). Recent research findings interpreted Internet blog-reported consequences of bed bug infestation such as sleeplessness, hypervigilance, and nightmares as possible cases of posttraumatic stress disorder (Goddard & de Shazo, 2012). Cases of delusional parasitosis have been reported both as a purely psychosocial phenomenon and as an immediate aftershock of cleared infestation (Frean, de Jong, & Albrecht, 2008). Bed bug–related skin conditions may add to mental stress (Mazzotti et al., 2003; Sampogna et al., 2004). Anecdotes of social ostracism—from job loss to dating barriers—have been noted in social networking outlets and other media (Feldman, 2011; Firger, 2010; United Press International, 2010).

In our study, we used self-reported data from a community-based municipal survey conducted by New York City's Department of Health and Mental Hygiene (DOHMH) in 2009 to estimate the prevalence and distribution of bed bug infestation in New York City. We used these data to explore possible determinants of infestation, including demographic and behavioral characteristics, household composition, and environmental characteristics. We also examined health and mental health characteristics as possible outcomes of infestation.

Methods

Data Source

The Community Health Survey is an annual representative cross-sectional telephone survey of New York City adults aged 18 and older. This survey is administered by DOHMH and collects self-reported measures of health, behaviors, and demographic characteristics using a neighborhood-stratified random sample. Details of the study and sampling scheme are reported elsewhere (Mostashari, Kerker, Hajat, Miller, & Frieden, 2005). Briefly, in 2009, responses to 125 questions were collected using a computer-assisted telephone interview format available in English, Spanish, Russian, or Chinese. Group residences, such as college dormitories, were excluded. Among households agreeing to participate, one adult was selected at random to complete the survey. The response rate was 34% for landline phones with a cooperation rate of 88%, and 50% for cell phones with a cooperation rate of 97%. This study was approved by the DOHMH institutional review board; the current analysis was considered exempt by the Hunter institutional review board.

Measures

We estimated prevalence, explored predictors of self-reported bed bug infestation, and examined whether bed bug infestation predicts key health outcomes. Bed bug infestation was measured as a dichotomous response to the question, "During the past 12 months, have you had a problem with bed bugs in your home that required an exterminator?"

Individual predictors of bed bug infestation included age (grouped as 18–24, 25–44, 45–64, or 65+ years), sex, race/ethnicity (Caucasian, African-American, Asian, or Hispanic; "other" [n = 175] was recoded as missing), education (less than high school, high school graduate, some college/technical school, or college graduate), household poverty status (<200% of federal poverty level [FPL] vs. ≥200% of FPL), partnership status (married/member of unmarried couple vs. divorced/widowed/separated/never married), and country of nativity (U.S. vs. foreign born). For behaviors, we explored number of sex partners in the past year (0–1 vs. 2 or more), as more sex partners could hypothetically be associated with greater exposure to bed bugs. Environmental predictors include neighborhood poverty levels (high, medium, low—based on tertiles of percentage of residents living with incomes <200% FPL), and number of units in building (1–2 units, 3–9 units, 10–49 units, and 50 or more units, by self-report).

In separate analyses, we examined the following health outcomes and coping mechanisms: first diagnosis of depression in last 12 months or nonspecific psychological distress (NSPD) to examine stress-related mental health issues; asthma episode in past 12 months or asthma-related emergency department visits in the past 12 months to explore possible effects of allergens or contaminants; and heavy alcohol drinking and binge drinking to investigate stress-related health impact. NSPD, described by Ridner as having five defining attributions of harmful psychological impairment (Ridner, 2004) was determined by the Kessler-6 scale, a standardized six-question short screening for mental health (Kessler et al., 2002). Heavy alcohol drinking was defined as >2/day for men and >1/day for women on days where the respondent drank, and binge drinking was defined as reporting five or more drinks on at least one occasion in the past 30 days (CDC, 2009). In models for select health outcomes, we included insurance status as a possible confounder due to the potential influence of differential likelihoods of diagnosis.

Data Analysis

We used SAS v. 9.2 for analysis. DOHMH-developed weights were applied to adjust for sampling methodology, adult telephone usage (Jacobs et al., 2010; New York City Department of Health and Mental Hygiene, 2010) and to reflect age, gender, and race distributions of neighborhoods. To identify factors associated with bed bug infestation, each covariate was analyzed in bivariate logistic regression using a Chi squared test; those with significant p-values of .05 or less were included in a final multivariable model. We quantified number of children by age group (<6 years old, 6–12 years old, or 13–17 years old), and number of adults aged 18 and older (recoded to 1, 2, and 3 or more) and included these measures in the adjusted bed bug model, regardless of bivariate significance, to examine infestation distribution by age.

To measure potential health effects of bed bug infestation, we created separate models for each health outcome. We selected potential confounders from significant variables in bivariate models with bed bugs as the outcome and, in a base model with bed bugs as the only predictor, we added each factor to the base model. If the covariate effected a 10% change in the beta coefficient for bed bug infestation, we added the covariate to the final adjusted model.

Results

In 2009, 6.7% of adults self-reported a bed bug infestation requiring an exterminator in the past year, with prevalence varying by borough (Table 1). Overall, the distribution showed a clearly graded, inverse relationship with age, ranging from 10.5% for those 18–24 years old to 3.5% for those 65+. Hispanic residents had the greatest prevalence (10.5%) followed by African-Americans (7.4%) (p < .01) compared to Caucasians (3.8%). Those

with low household income (≤200% of FPL) had significantly higher reported infestations compared with those with higher income (12.0% vs. 3.6%). This pattern was consistent with two other measures of socioeconomic status: education (12.4% for less than high school through 4.5% for college graduate, $p < .01$) and neighborhood poverty levels (10.9% for high poverty neighborhoods and 3.2% for low poverty neighborhoods, $p < .01$).

A higher burden occurred among respondents with any children under 18 years of age, and we observed a positive gradient of association with total number of children (data not shown). When number of children was categorized by age, the gradient by number of children for infestation was most pronounced for households with children of younger ages (Table 1). Likewise, number of adults in the household showed a positive gradient with infestations. Respondents reporting having no or one sexual partner in the past year reported fewer infestations than those having two or more (6.7% vs. 10.5%, $p = .01$).

In the adjusted model, only younger age of the respondent (18–24 compared to 65+, adjusted odds ratio [a*OR*] = 2.0; and 25–44, a*OR* = 1.8), household poverty status below 200% of FPL compared to higher income (a*OR* = 2.7), three or more adults in the household compared with one (a*OR* = 1.6), and highest tertile of neighborhood poverty compared with lowest tertile (a*OR* = 1.9) were significant positive predictors of bed bug infestation (Table 2). Living in a 1–2 unit building was protective compared to living in a building with 50 or more units (a*OR* = 0.4). Associations of bed bug infestations with race and with number of children were not significant in the adjusted model.

Prevalence of health outcomes and coping mechanisms were first diagnosis of depression in last 12 months, 3.9% (95% confidence interval [*CI*] = 3.4–4.5); NSPD, 5% (95% *CI* = 4.4–5.7); heavy alcohol drinking, 4.8% (95% *CI* = 4.1–5.5); binge drinking, 15% (95% *CI* = 13.8–16.2); episode of asthma in the past 12 months, 4.1% (95% *CI* = 3.4–4.6), and asthma-related emergency department visits in the past 12 months, 2.0% (95% *CI* = 1.6–2.3). Only NSPD was significantly associated with self-reported bed bug infestations in unadjusted models. This association was not significant, however, in adjusted models (Table 3). Emergency visit for asthma in the

TABLE **1**

Self-Reported Bed Bug Infestation Requiring Exterminator in Past 12 Months by Sociodemographic Characteristics and Health Indicators, 2009

	Total #[a]	Total %	95% *CI*[b]
Total Reported Bed Bug Infestation	558	6.7	5.9, 7.5
Demographics of respondents			
Age			
18–24	42	10.5	6.8, 14.3
25–44	202	7.7	6.3, 9.1
45–64	210	5.3	4.2, 6.4
65+	101	3.5	2.7, 4.4
Sex			
Males	211	6.6	5.3, 7.9
Females	347	6.7	5.7, 7.8
Race/ethnicity			
Caucasian, non–Hispanic	144	3.8	2.9, 4.7
African-American, non–Hispanic	146	7.4	5.5, 9.3
Hispanic	221	10.9	8.8, 12.9
Asian	39	6.2	3.5, 8.9
Poverty levels			
≤200% federal poverty level	323	12.0	10.1, 13.9
>200% federal poverty level	157	3.6	2.8, 4.5
Education (highest grade)			
Less than high school	143	12.4	9.4, 15.3
Grade 12/GED	145	7.5	5.6, 9.3
Some college	121	6.7	4.9, 8.4
College graduate	145	4.5	3.4, 5.6
U.S. born (yes)	266	5.3	4.3, 6.4
No	285	8.5	7.1, 9.9
Household makeup			
Partnership status			
Married/member of unmarried couple	216	6.5	5.4, 7.7
Divorced/separated/widowed/never married	336	6.9	5.7, 8.1
Children <6 yrs.			
None	442	5.7	4.9, 6.6
One	74	8.8	6.0, 11.7
Two or more	40	13.1	8.4, 17.8
Children 6–12 yrs.			
None	436	6.0	5.2, 6.9
One	79	8.6	5.7, 11.4
Two or more	41	12.0	7.3, 16.7
Children 13–17 yrs.			
None	453	6.3	5.4, 7.1
One	85	10.0	6.7, 13.3
Two or more	18	5.4	2.4, 8.5
Number of adults			
One	241	5.2	4.1, 6.3
Two	186	6.1	4.9, 7.3
Three or more	131	9.0	7.0, 11.0

continued ▸

TABLE **1** *continued*

Self-Reported Bed Bug Infestation Requiring Exterminator in Past 12 Months by Sociodemographic Characteristics and Health Indicators, 2009

	Total #[a]	Total %	95% *CI*[b]
Environmental			
Units in building			
1–2	86	3.4	2.4, 4.5
3–9	118	9.8	7.3, 12.2
10–49	151	8.8	6.7, 11.0
50 or more	163	6.3	4.8, 7.8
Neighborhood poverty status			
High poverty	272	10.9	8.9, 12.9
Medium poverty	186	5.8	4.6, 7.0
Low poverty	95	3.2	2.2, 4.2
Borough			
Bronx	106	8.1	5.8, 10.3
Brooklyn	186	8.9	7.1, 10.8
Manhattan	129	5.8	4.0, 7.6
Queens	113	5.0	3.8, 6.3
Staten Island	24	2.5	1.3, 3.7
Behaviors			
Heavy alcohol drinker (yes)	22	6.2	2.3, 10.2
No	523	6.6	5.8, 7.4
Binge alcohol drinker (yes)	74	7.3	5.0, 9.6
No	479	6.6	5.7, 7.5
Number of sexual partners			
None or one	441	6.7	5.7, 7.6
Two or more	64	10.5	7.1, 13.9

[a]Not weighted.
[b]*CI* = confidence interval.

past 12 months was not associated with bed bug infestation (*OR* = 1.5, 95% *CI* = 0.6–4.3), although only 33 households with bed bug infestations reported a recent emergency visit for asthma.

Discussion

This analysis is one of the first population-based studies to estimate the prevalence and associated predictors of reported bed bug infestation in an urban setting. In 2009, nearly one in 15 New York City households (6.7%) reported a bed bug infestation in the past year, with significant differences across the city's boroughs. In the adjusted model, the only individual-level factor associated with infestation was younger age, and at the household level, the only factors associated with infestation were household poverty and number of adult residents, echoing literature on other insect infestations (Rauh et al., 2002). Significant environmental factors included neighborhood poverty and number of units in the building.

The exact role of these factors in bed bug transmission is unknown. Possibilities proposed in previous literature are bed bug hitchhiking and apartment-to-apartment travel (Delaunay et al., 2011). Of these, hitchhiking is relevant to the broadest spectrum of the population. Age may be a marker for social behaviors that increase bed bug hitchhiking, such as differences in frequency and breadth of socialization; different use of transportation; different use of libraries, schools, or other public spaces; frequency of obtaining used furniture or clothing; and local or international travel.

Our finding that more adults in the household increase infestation risk may reflect a greater aggregate exposure or a greater likelihood of younger adults, with higher risk of introduction through hitchhiking. Because we do not know ages of other adults in the household we were unable to examine the impact of number of adults by age group. In spite of differential infestation prevalence by number of younger children, this was not associated with infestation in the fully adjusted model.

Household poverty could increase the risk of hitchhiking through acquisition of used clothing or property or frequenting public services. Neighborhood poverty may promote greater hitchhiking transmission through more social contact in high density housing. It may also reflect more frequent contact with a population at higher risk from poor building management, increasing building-to-building transmission in low-income neighborhoods.

These findings can also be interpreted to support apartment-to-apartment transmission: for household predictors, the greater likelihood of infestation among higher poverty households may reflect the lack of resources, recourse, and self-efficacy of tenants to ensure effective building management (Messer, 2011). We found that building size is positively correlated with infestation risk with lower levels of infestation in 1–2 unit buildings. If points of egress for bed bugs (door jambs, pipes, or conduit) between apartments above, below, or adjacent have not been appropriately sealed, more bed bugs may travel within the building and between apartments. In these smaller buildings, introduction must come from outside or from only one adjacent apartment; in larger buildings a greater potential exists for risk from adjacent units. Larger buildings may have more transfer from common areas, such as lobbies or laundry rooms, or from other building features associated with unit count. Although unit count may be confounded by risk factors such as income, household size, and neighborhood, further examination of bed bug infestation by building type may identify building-level risks and offer guidance for methods of pest control.

Bed bug infestation was not statistically significantly associated with any health or mental health outcomes examined. Unlike cockroaches, which are known asthma trig-

gers (Arruda et al., 2001), bed bugs showed no association with asthma exacerbation. Although factors such as limited study power to detect a small effect or different pest control strategies from a higher perceived nuisance factor may hide an asthma episode risk, little evidence exists to support the likelihood of an association being masked by behaviors or study limitations. Our findings from a representative population-based survey did not support the findings from a previous case series of 11 bed bug–infested households that suggested a possible association with asthma (Abou Gamra et al., 1991).

Our findings do suggest other potential health disparities that could result from this distribution of infestation. For example, in low-income housing, more infestations may augment the burden of pesticide exposure. While families with children under six were not at elevated risk, they did report a high prevalence of infestation, and young children are vulnerable to substantially greater health risks from improper pesticide use (Lu, Barr, Pearson, Walker, & Bravo, 2009; Turner, Wigle, & Krewski, 2010).

Our study had a number of limitations. Cross-sectional data limit conclusions about temporal order of measures. Characteristics such as age, poverty, and children's ages likely predate our measure of infestation *in the past year*; however, health and mental health outcomes may have occurred concurrent with, or prior to, infestations. Any effects of infestations in prior years were not captured, and outcomes with some latency could be underestimated. Asthma in particular is usually diagnosed before adulthood, and we have no data on incidence of new asthma among children in the respondents' households. Some infestations reported here may represent ongoing infestations, which may have different distribution and health outcomes, and risks related to pesticide use may depend both on cumulative exposure and time.

Our analysis relied on self-report to estimate infestation prevalence. Bed bugs are small, hide during the day, and change appearance in different life stages. This could lead to misidentification, which might be differential within subgroups (Reinhardt, Kempke, Naylor, & Siva-Jothy, 2009). Media coverage may influence bed bug identification (Anderson & Leffler, 2008). Subpopulations may report differently due to stigma or to specific pressing health concerns. Bite sensitivity may also influence bed bug reporting, and population prevalence and distribution of bite sensitivity is largely unknown. Nevertheless, self-report may be the best measure of the *impact* of the bed bug resurgence; for example, some individuals with true infestations may experience less anxiety or stress from bed bugs than others who are not infested but fearful of infestation. As more information becomes available, self-report may prove to be an accurate marker of infestation levels.

Our survey was also limited because it qualified infestations as those requiring an exterminator, and factors such as cost, experience, cultural norms, and overall health

TABLE **2**

Demographic Neighborhood and Behavioral Characteristics as Predictors of Self-Reported Bed Bug Infestation Requiring Extermination in Past 12 Months, 2009[a]

Demographic	Unadjusted	Adjusted Model
	***OR* (95% *CI*)[b]**	**a*OR*[c] (95% *CI*)**
Age (ref. = 65+)		
18–24	***3.2 (2.0, 5.2)***	***2.0 (1.1, 3.6)***
25–44	***2.3 (1.7, 3.1)***	***1.8 (1.1, 2.8)***
45–64	***1.5 (1.1, 2.1)***	1.3 (0.8, 2.0)
Race/ethnicity (ref. = Caucasian, non-Hispanic)		
African-American, non-Hispanic	***2.0 (1.4, 2.9)***	1.3 (0.8, 2.0)
Hispanic	***3.1 (2.2, 4.3)***	1.2 (0.8, 2.0)
Asian	1.7 (0.99, 2.8)	1.5 (0.8, 2.7)
Nativity (ref. = U.S. born)		
Foreign born	***1.6 (1.3, 2.2)***	0.9 (0.6, 1.3)
Poverty status (ref. = ≥200% federal poverty level [FPL])		
<200% FPL	***3.6 (2.7, 4.9)***	***2.8 (1.9, 4.0)***
Neighborhood poverty status (ref. = low poverty)		
Medium poverty	***1.9 (1.3, 2.8)***	1.2 (0.7, 1.9)
High poverty	***3.7 (2.5, 5.5)***	***1.9 (1.1, 3.1)***
Units in building (ref. = 50+ units)		
1–2	***0.5 (0.4, 0.8)***	***0.4 (0.3, 0.7)***
3–9	***1.6 (1.1, 2.4)***	1.1 (0.7, 1.6)
10–49	***1.4 (1.0, 2.1)***	1.0 (0.6 1.5)
Children <6 yrs. (ref. = none)		
One	***1.6 (1.1, 2.3)***	1.0 (0.6, 1.6)
Two or more	***2.5 (1.6, 3.8)***	1.7 (0.95, 3.0)
Children 6–12 yrs. (ref. = none)		
One	1.5 (0.98, 2.2)	1.0 (0.7, 1.6)
Two or more	***2.1 (1.3, 3.4)***	1.2 (0.6, 2.1)
Children 13–17 yrs. (ref. = none)		
One	***1.7 (1.1, 2.5)***	1.5 (0.96, 2.4)
Two or more	0.9 (0.5, 1.6)	0.7 (0.3, 1.4)
Number of adults (ref. = one)		
Two	1.2 (0.8, 1.6)	1.1 (0.7, 1.5)
Three or more	***1.8 (1.3, 2.5)***	***1.6 (1.1, 2.4)***
Number of sexual partners (ref. = none or one)		
Two or more	***1.7 (1.1, 2.4)***	***1.6 (1.01, 2.6)***

[a]Weighted, and accounting for stratified sample. Significant associations in bold and italics.
[b]*OR* (95% *CI*) = odds ratios, 95% confidence interval.
[c]a*OR* = adjusted odds ratios.

TABLE **3**

Unadjusted and Adjusted Models of Predictors of Nonspecific Psychological Distress (NSPD) and Depression Including Self-Reported Bed Bug Infestation, 2009[a]

Characteristic	NSPD		Depression Ever	
	Unadjusted	Adjusted Model 1	Unadjusted	Adjusted Model 1
	OR (95% *CI*)[b]	a*OR*[c] (95% *CI*)	*OR* (95% *CI*)	a*OR* (95% *CI*)
Bed bugs (yes vs. no)	***2.2 (1.5, 3.4)***	***1.5 (0.9, 2.4)***	***1.6 (1.1, 2.1)***	***1.4 (0.96, 2.0)***
Age (ref. = 65+)				
18–24	0.8 (0.4, 1.6)		***0.5 (0.3, 0.8)***	1.1 (0.6, 2.0)
25–44	1.1 (0.8, 1.5)		0.9 (0.7, 1.1)	***2.0 (1.4, 2.9)***
45–64	1.3 (1.0, 1.8)		***1.4 (1.1, 1.7)***	***2.9 (2.1, 3.9)***
Race/ethnicity (ref. = Caucasian, non-Hispanic)				
African-American, non-Hispanic	1.1 (0.7, 1.6)		***0.5 (0.4, 0.6)***	***0.4 (0.3, 0.5)***
Hispanic	***1.7 (1.2, 2.3)***		***0.8 (0.7, 1.0)***	***0.7 (0.5, 0.9)***
Asian	1.3 (0.8, 2.3)		***0.4 (0.3, 0.6)***	***0.5 (0.3, 0.8)***
Poverty status (ref. = ≥200% federal poverty level [FPL])				
<200% FPL	***3.1 (2.2, 4.3)***	***2.2 (1.3, 3.6)***	1.3 (1.1, 1.6)	1.6 (1.2, 2.1)
Education (highest grade) (ref. = college graduate)				
Less than high school	***2.9 (2.0, 4.2)***	1.4 (0.9, 2.3)	1.2 (0.9, 1.5)	***0.6 (0.4, 0.8)***
Grade 12/GED	***1.5 (1.0, 2.2)***	0.8 (0.5, 1.3)	0.9 (0.7, 1.1)	0.9 (0.7, 1.3)
Some college	***1.7 (1.1, 2.6)***	1.1 (0.7, 1.8)	1.5 (1.1, 2.0)	0.8 (0.6, 1.03)
U.S. born (no vs. yes)	1.2 (0.9-1.6)		***0.6 (0.5, 0.8)***	***0.6 (0.5, 0.8)***
Neighborhood poverty status (ref. = low poverty)				
High poverty	1.4 (1.0, 2.0)		1.1 (0.9, 1.3)	
Medium poverty	1.2 (0.9, 1.8)		0.9 (0.7, 1.1)	
Units in building (ref. = 50+ units)				
1–2	***0.6 (0.4, 0.8)***	0.9 (0.6, 1.4)	***0.5 (0.4, 0.7)***	***0.7 (0.5, 0.9)***
3–9	1.1 (0.8, 1.7)	1.1 (0.7, 1.8)	0.8 (0.6, 1.0)	0.9 (0.7, 1.2)
10–49	0.9 (0.6, 1.4)	***0.7 (0.4, 0.97)***	0.9 (0.7, 1.1)	0.9 (0.6, 1.2)
Children <6 yrs. (ref. = none)				
One	0.9 (0.6, 1.4)	0.9 (0.6, 1.5)	0.8 (0.6, 1.1)	0.9 (0.7, 1.4)
Two or more	***0.4 (0.2, 0.8)***	***0.4 (0.2, 0.8)***	***0.5 (0.3, 0.8)***	***0.5 (0.3, 0.9)***
Children 6–12 yrs. (ref. = none)				
One	1.1 (0.7, 1.8)		0.9 (0.7, 1.2)	
Two or more	1.0 (0.5, 2.0)		0.8 (0.5, 1.2)	
Children 13–17 yrs. (ref. = none)				
One	0.9 (0.6, 1.4)		0.9 (0.7, 1.2)	
Two or more	1.0 (0.6, 1.9)		***0.6 (0.4, 0.97)***	
Number of adults (ref. = one)				
Two	0.8 (0.6, 1.1)		***0.7 (0.6, 0.8)***	***0.7 (0.6, 0.9)***
Three or more	1.0 (0.7, 1.4)		***0.6 (0.4, 0.7)***	***0.7 (0.5, 0.9)***
Number of sexual partners (ref. = none or one)				
Two or more	1.5 (0.9, 2.3)		1.3 (0.97, 1.7)	
Insurance type (ref. = Medicaid/Family Health Plus)				
Private	0.3 (0.2, 0.4)	***0.6 (0.3, 0.97)***	***0.5 (0.4, 0.6)***	1.2 (0.8, 1.8)
Medicare	0.8 (0.5, 1.1)	0.9 (0.6, 1.4)	1.0 (0.8, 1.3)	***0.5 (0.3, 0.9)***
Others	0.6 (0.3, 1.4)	0.8 (0.3, 2.0)	***0.6 (0.4, 0.9)***	***0.5 (0.4, 0.7)***
Uninsured	***0.6 (0.4, 0.96)***	0.7 (0.4, 1.1)	***0.4 (0.3, 0.6)***	***0.4 (0.3, 0.6)***

[a]Weighted, and accounting for stratified sample. Significant associations in bold and italics.
[b]*OR* (95% *CI*) = odds ratios, 95% confidence interval.
[c]a*OR* = adjusted odds ratios.

may have an impact on the use of pest control services. Lastly, New York City's population and housing stock is unique, diverse, and subject to local environmental characteristics and municipal policies that may have affected bed bug transmission and limit generalizability of these findings.

Despite possible reporting biases in our study, these findings may help evaluate and interpret other administrative data sources, such as New York City and other municipal levels of complaints and building violations.

Conclusion

Household and neighborhood-level poverty are associated with increased risk of bed bug infestations, suggesting that costs related to extermination may be an important barrier to pest control. As infestation may be transmitted among and within buildings; families living in disadvantaged neighborhoods with endemic control issues may be more heavily exposed to a greater reservoir of bed bugs, possibly furthering the high risk in an already burdened population and making neighborhood-level control more difficult. Building characteristics may play a role in transmission and should be investigated. Differentiated risk for younger ages and larger household size suggest a need for targeted community interventions and public education models.

Although no health or mental health outcomes including exacerbated asthma showed an association with infestation, differentiated prevalence, particularly among families with young children, may warrant targeted education around potential pesticide exposure. In future research, determining whether bite sensitivity is a confounder of infestation estimates may help validate self-reporting as a measure of infestation.

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Environmental Health—Champions of One Health

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Abstract **The authors find overwhelming evidence among environmental health practitioners that One Health disease reporting concepts are essential to the early detection of, and expedient recovery from, pandemic disease events. The authors also find, however, extraordinary evidence that local public health is not prepared, and potentially unaware of their responsibility, to be the initiator of the zoonotic infectious disease information intelligence necessary to make such early event mitigation possible. The authors propose that NEHA take an affirmative step towards the development of local public health–initiated biosurveillance systems by organizing and leading a tabletop study group that includes the Centers for Disease Control and Prevention, American Veterinary Medical Association, American Medical Association, Food and Drug Administration, U.S. Department of Agriculture, Institute of Medicine, and a robust panel of NEHA state affiliates. This study group should discuss the infrastructure necessary for local public health—the frontline against community-acquired infectious disease—to be the initiators of environmental health, veterinary, and medical One Health biosurveillance systems. The need to establish a community-focused, integrated disease prevention strategy that cautions people about the risks associated with food, water, animal, and contaminated environmental media, both prior to and during epidemic and pandemic events is equally important.**

Introduction

"One Health," as defined by the American Veterinary Medical Association (AVMA), is "one strategy to better understand and address the contemporary health issues created by the convergence of human, animal, and environmental domains (AVMA, 2008)." Since 2008, One Health has been endorsed by the environmental health and medical cornerstone professional health organizations: the American Medical Association (AMA) and NEHA. One Health as a general concept is best described by the need to integrate environmental health, veterinary, and medical disciplines to accomplish the meaningful prevention of zoonotic disease (specifically epidemic and pandemic events), through a coordinated stream of disease surveillance intelligence exchange systems (Eddy, Sase, & Schuster, 2010).

Biosurveillance as initially described by Homeland Security Presidential Directive 21 and modernized by the Centers for Disease Control and Prevention (CDC), the Department of Homeland Security (DHS), and the Institute of Medicine (IOM), however, is dependent upon "local up" (meaning that local public health is the source of zoonotic disease intelligence, not the "top down" recipient) surveillance intelligence networks (Bush, 2007; DHS, 2012). We find overwhelming evidence among environmental health practitioners that One Health disease reporting concepts are essential to the early detection of, and expedient recovery from, pandemic disease events. We also find that local public health is not prepared, and potentially unaware of their responsibility, to be the initiator of the zoonotic infectious disease information intelligence necessary to make such early event mitigation possible. We propose that NEHA take an affirmative step towards the development of local public health–initiated biosurveillance systems by organizing and leading a tabletop study group that includes CDC, AVMA, AMA, the Food and Drug Administration (FDA), U.S. Department of Agriculture (USDA), the Institute of Medicine (IOM), and a robust panel of NEHA state affiliates. This study group should discuss the infrastructure necessary for local public health—the frontline against community-acquired infectious disease—to be the initiators of environmental health, veterinary, and medical One Health biosurveillance infectious disease systems. The development of a sophisticated and integrated residential, community health public information system that cautions people about the risks associated with food, water, animal, and contaminated environmental media is equally important.

Biosurveillance

Pandemic influenza H1N1 2009 has proven that little direct evidence exists of environmental health, veterinary, and medical information exchange systems in place or

TABLE **1**

Responses of NEHA and Association of Ohio Health Commissioners (AOHC) Survey Participants

Question	Response	
	Agreement	
	NEHA # (%)	AOHC # (%)
1.) Will pandemic events likely be zoonotic in origin?	44 (91)	46 (98)
2.) Will hospital-acquired infection increase proportionate to surge capacity expansion and exceedance?	44 (91)	37 (79)
3.) Do you think that companion animals can adversely affect the health of an immunocompromised patient?	37 (77)	44 (94)
4.) Do you participate in a syndromic zoonotic disease reporting system presently (other than rabies and mosquito-borne disease)?	19 (39)	10 (21)
5.) Is it important to establish sentinel, syndromic zoonotic disease reporting systems?	48 (100)	45 (95)
6.) Do you think that local veterinary/medical/public health cooperatives can help predict and prepare for disasters?	45 (94)	39 (83)
7.) Do you think public health has been involved directly in One Health?	16 (33)	5 (11)
8.1) Should NEHA* pursue a lead role in zoonotic disease reporting?	40 (83)	N/A
8.2) Should AOHC* pursue a lead role in zoonotic disease reporting?	N/A	40 (86)

*NEHA response based on 48 respondents. AOHC response based on 47 respondents.

functional in the U.S. nor in the rest of the industrialized world (Eddy et al., 2010). Given that 75% of all emerging infectious diseases are zoonotic, it is likely that diseases like avian influenza and future novel pathogens will continue to evade early detection systems and the vaccination preparation processes currently in place (Centers for Disease Control and Prevention, 2013). According to the National Biosurveillance Integration Center, biosurveillance is

"the science and practice of managing human, animal, plant, food, and environmental health related data and information for early warning of threats and hazards, early detection of events, and rapid characterization of the event so that effective actions can be taken to mitigate adverse health, social, and economic effects (DHS, 2012)."

In the 2012 IOM report, "Applications to Integrated Biosurveillance Workshop Summary," it is recommended that biosurveillance efforts are initiated at the local level (Institute of Medicine [IOM], 2012). Recent documentation by the National Biosurveillance Integration Center highlights federally based programs contrary to the IOM's vision of biosurveillance (DHS, 2012).

The 2011 World Health Organization (WHO) critique of the first-ever implementation of the 2005 International Health Regulation (IHR) found that the world is not only poorly prepared for events like the 2009 H1N1 global pandemic, but is especially lacking in capacity for other novel pathogen-originated pandemics (World Health Organization [WHO], 2011). The solution to this inadequacy, according to the IHR Review Committee, is "collaboration between public health and animal-health sectors (WHO, 2011)." The October 2011 Bio-Response Report Card states that "current biosurveillance approaches do not adequately involve or integrate data from entities outside of public health (i.e., clinical sector, private sector, animal, food, water, etc.), slowing governments' ability to detect and respond to large-scale, multisector outbreaks, such as foodborne illness (Bipartisan Weapons of Mass Destruction Research Center, 2011)." The CDC report, "Food Safety Epidemiology Capacity in the United States, 2010," finds that a survey of all 50 states shows that many states lack core epidemiologic capacity and lack the ability to "support surveillance (Boulton & Rosenberg, 2011)." While it may be the result of confusion among health professionals regarding their role in One Health and the types of surveillance systems they ought to be involved with, we theorized that the capacity for One Health biosurveillance disease intelligence systems is not adequate at present.

Methods

To test the hypothesis, surveys were conducted of environmental health professionals representative of local public health at the following two state and national educational conferences:

1) The 2009 Association of Ohio Health Commissioners (AOHC) Annual Education Conference, September 30, 2009, Columbus, Ohio.
2) The 2009 NEHA Annual Educational Conference & Exhibition, June 22, 2009, Atlanta, Georgia.

Both populations were surveyed using TurningPoint, a real-time, anonymous "voting" software platform. Individual "voting cards" were distributed to audience members, but were limited to 50 individuals per session. Those surveyed were not asked to identify themselves nor was any information about their personal identity recorded.

Data

A high level of agreement existed that the next pandemic event will be zoonotic in nature (both groups averaged 94%); that it is important to establish biosurveillance systems (both groups averaged 97%); and that the biosurveillance reporting systems can signal the beginning of an infectious disease event early enough to minimize its impact (both groups averaged 88%) (Table 1). Seventy percent (average) of both groups surveyed reported, however, that they do not presently participate in a biosurveillance disease reporting system. Surveyed local public health officials agreed (both groups averaged 85%) that maximum hospital surge capacity will increase cases of hospital-acquired infection. Surveyed local public health officials also agreed (both groups averaged 85.5%) that privately owned companion pets can adversely affect the health of vulnerable populations when pandemic disease events occur in the community.

The results indicate that practitioners believe strongly that coordinated sentinel environmental health, veterinary, and human medical biosurveillance disease reporting systems can signal the beginning of an infectious disease

event early enough to minimize its impact; however, data indicate they are not presently engaged in meaningful biosurveillance systems. In practice, One Health concepts are proven to be largely unimplemented: surveyed public health officials reported (both groups averaged 70%) they do not participate. Likewise, only 22% of those surveyed (both groups averaged) reported that they believe public health has been directly involved in One Health. Both surveyed groups agreed (both groups averaged 84%) that that their own professional organizations, NEHA, and AOHC should initiate lead roles in coordinating and implementing such One Health biosurveillance systems.

Discussion and Conclusion

Our data support the IOM biosurveillance tabletop findings that local public health is the foundational component of a real time biosurveillance program: providing early detection data from the "bottom up" to state and federal resources (IOM, 2011). We also find that local environmental health professionals agree strongly that environmental health, veterinary, and medical public health collaboratives must be created to achieve disaster preparedness and early event recovery. A sea change in public health policy must occur at local and state levels first, before any meaningful federal success can be acquired. This yet-to-be-developed system should be in alignment with global biosurveillance disease early detection systems integrating all nations. These systems would provide the means necessary for early detection, response, and mitigation of novel or re-emerging pathogens (Eddy et al., 2010). The findings from our study also highlight the need for escalating public health education programs directed towards vulnerable populations including pet owners and other animal handlers.

Equally necessary, as Eddy and co-authors also point out, is the development of a sophisticated residential community health public information system that cautions people about the risks associated with food, water, animal, and contaminated environmental media. The pace of intelligence gathering and the public dissemination of disease-specific infection pathways (and associated prevention strategies) may limit the amplification of disease in the community and allow early event recovery. The message must be relayed to the public and further reinforced by media during epidemic and pandemic events through a community-focused, integrated disease prevention strategy.

The Role of NEHA in One Health

We encourage NEHA to lead its constituency towards the integration of state and federal biosurveillance systems. Environmental health professionals are key, due to skill set and locale, to serve as the bedrock of biosurveillance systems. We advocate that the movement known as One Health should find a leader that will take responsibility for bringing the collective groups together in order to achieve "local up" biosurveillance capacity; NEHA would be an ideal candidate for this position. More specifically, we suggest that NEHA organize and lead a tabletop study group that invites CDC, AVMA, AMA, FDA, USDA, and IOM to join a robust panel of NEHA state affiliates to discuss the infrastructure necessary to implement local-origin biosurveillance systems.

While veterinarians and physicians are both subject-matter experts in their respective fields, they both can reside within the broader realm of environmental health. Serving as a bridge or mediator, NEHA would be able to not only offer expert technical advice regarding environmental sources of zoonotic disease but also foster a worthy image for the public health workforce that has historically been the face of response in pandemic events such as the case of pandemic influenza H1N1 2009.

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Did You Know?

NEHA offers two free online courses on environmental public health tracking. Both "Tracking in Action" and "Tracking 101" provide background and training about tracking and how it intersects with environmental health. Earn NEHA continuing education credits by completing the courses. Go to www.nehacert.org/moodle/ and choose "Free CDC & EPA Courses" to find these online courses.

DIRECT FROM ATSDR

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An Indicator Framework to Measure Effects of Brownfields Redevelopment on Public Health

Editor's Note: **As part of our continuing effort to highlight innovative approaches to improving the health and environment of communities, the *Journal* is pleased to publish a bimonthly column from the U.S. Agency for Toxic Substances and Disease Registry (ATSDR). The ATSDR, based in Atlanta, Georgia, is a federal public health agency of the U.S. Department of Health and Human Services and shares a common office of the Director with the National Center for Environmental Health at the Centers for Disease Control and Prevention (CDC). ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances.**

The purpose of this column is to inform readers of ATSDR's activities and initiatives to better understand the relationship between exposure to hazardous substances in the environment and their impact on human health and how to protect public health. We believe that the column will provide a valuable resource to our readership by helping to make known the considerable resources and expertise that ATSDR has available to assist communities, states, and others to assure good environmental health practice for all is served.

The conclusions of this article are those of the author(s) and do not necessarily represent the views of ATSDR, CDC, or the U.S. Department of Health and Human Services.

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Introduction

Brownfields and land reuse sites (brownfields) are formerly used industrial, commercial, and residential properties stigmatized by real or perceived contamination. The effects of blight and potential contamination associated with these sites can weigh heavily on communities. Communities with multiple brownfields tend to have multiple public health issues. The issues include reduced property values, increased potential for exposures to harmful chemicals, increased crime rates, substance abuse, lack of green space or areas for recreation, decreased access to healthy foods, poor air quality, contaminated soil or water, and elevated blood lead levels or asthma prevalence, among others.

The Agency for Toxic Substances and Disease Registry's (ATSDR's) Brownfields/Land Reuse Health Initiative offers technical support and resources to communities to encourage the inclusion of public health in revitalization plans. The ATSDR Brownfields/Land Revitalization Action Model (Action Model) is one resource designed to integrate public health in redevelopment by creating community-driven health status indicators.

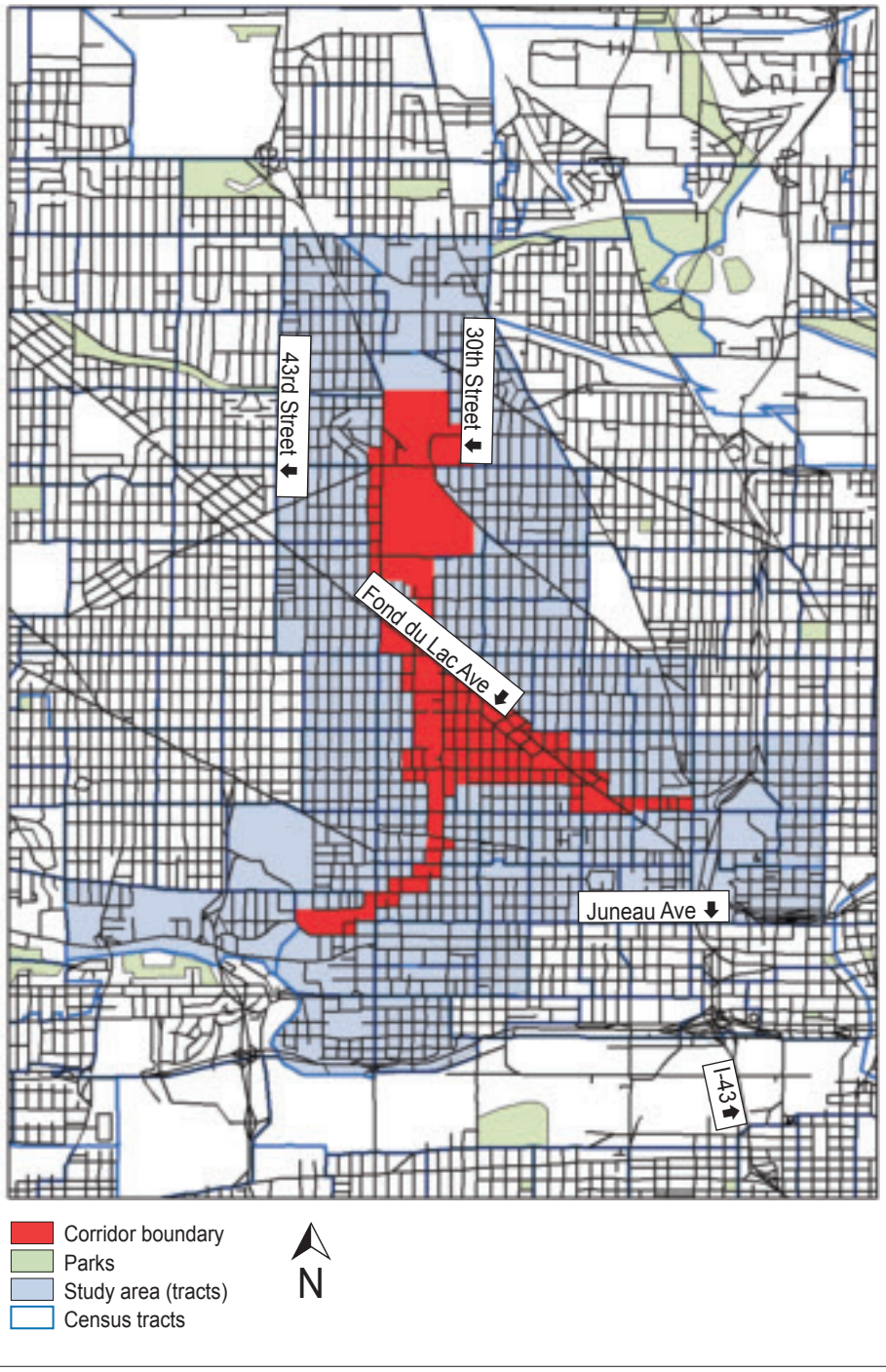
Prior to developing the Action Model, ATSDR researched existing community assessment frameworks and found that these frameworks primarily focused on sustainable development, health promotion, and health status assessment. This review indicated that a community-driven emphasis was lacking and revealed a need for a community-driven model inclusive of grass roots public health indicators to address the adverse effects of brownfields in communities. Because communities with multiple brownfields tend to be disproportionately affected economically, the need for an indicator framework that can be implemented with little to no funding sources or with no consultant facilitation is critical.

Developing the Action Model in Milwaukee's 30th Street Corridor

The Menomonee Valley Benchmarking Initiative (DeSousa, Gramling, & Lemoine, 2007) is one of the most comprehensive projects that incorporates stakeholder-derived indi-

FIGURE **1**

30th Street Corridor Report Study Area—Tracts



cators to assess changes in a redeveloping area. In summer 2006, ATSDR met with the original project stakeholders and asked for their assistance in piloting the Action Model framework to determine measurable outcomes for the assessment of the effects of redevelopment on community health status. Later, we all worked together to implement the framework in the 30th Street corridor of Milwaukee, an urban corridor with a population of about 90,000 people (Figure 1). The project is described in the ATSDR (2008) report, "Building Healthy Communities: A Baseline Characterization of Milwaukee's 30th Street Corridor."

The ATSDR Action Model resulted in a grassroots framework implemented by a diverse group of stakeholders—the Development Community—without a large investment of resources. Key aspects of the Action Model include the following:

- forming the Development Community,
- completing a four-step framework to establish baseline community health status, and
- adding stewardship that ensures all indicators are tracked over time.

Forming the Development Community

The Development Community consisted of anyone interested in redevelopment of the 30th Street corridor. Development Community members recommended who should be involved, which helped ATSDR to equitably include key stakeholders. The Development Community included many community groups, residents, the city of Milwaukee, the Milwaukee Health Department, the University of Wisconsin—Milwaukee, the Wisconsin Department of Natural Resources, the Wisconsin Department of Health Services, the U.S. Environmental Protection Agency (U.S. EPA), and ATSDR.

Implementing the Action Model Framework

During public workshops, Development Community members brainstormed issues following four framework steps. These steps are summarized below and in Table 1.

Step 1. What are the issues in the community that may impact the health of the community? Members of the Development Community identified seven general issues of concern. These issues fell into four broader topics: health, community, land and environment, and buildings and infrastructure.

Step 2. How can redevelopment address the issues that impact health status? Members of the Development Community identified various ways that redevelopment activities in the 30th Street corridor might help to address these issues.

Step 3. What are the community health benefits? The Development Community listed

TABLE **1**

Results of the Agency for Toxic Substances and Disease Registry's Brownfields/Land Revitalization Action Model in Milwaukee's 30th Street Corridor

Category	What Are the Community Issues?	How Can Redevelopment Address the Issues?	What Are the Community Health Benefits?	What Data Are Needed to Measure Change?
Health	Exposure to harmful substances in the environment, such as those at brownfields sites or in old housing stock, is one of many risk factors for diseases and adverse health effects (e.g., asthma, high blood lead levels).	Environmental cleanups at brownfields sites may reduce risk of exposure to harmful substances. In addition, renovation of old housing stock and construction of newer homes may help to further reduce exposures to harmful substances.	Reduced blood lead levels, reduction of learning disabilities in children, fewer hospitalizations for asthma, fewer infant deaths, and fewer low birth weight infants. May also reduce exposures to carcinogens.	Hospitalizations for asthma Infant mortality rate Lead and copper in tap water Lead poisoning in children Low birth weight
Community	Elevated crime rates are detrimental to the overall health and well-being of the community.	Development of abandoned sites, vacant lots, and vacant buildings may reduce areas where certain crimes occur and create a better sense of community among local residents.	Reduced crime-related injury and death. Reduced fear of crime, likely resulting in increased mobility of local residents.	Acreage of vacant lots Violent crimes
	Because of lower educational attainment levels, local residents may not be competitive in the labor force and thus not receive the benefits from full-time employment.	Improvements at existing educational facilities and development of new educational centers (e.g., vocational schools, community centers) may promote the educational development of youth in the community.	Increased educational attainment, employability, health insurance coverage, and understanding of health topics and information.	Education of adults Third grade reading comprehension
	A lack of jobs is contributing to a high poverty rate, leaving residents with limited resources to access medical care and improve the residential infrastructure.	Whether through renovating abandoned or deserted buildings or constructing new ones, redevelopment activities designed to attract business can bring jobs into the community.	Lower unemployment rates and poverty may increase health insurance coverage. People may be able to afford better housing and crime rates may decrease.	Percentage of adults with health benefits Percentage of people employed Percentage of people living in poverty
Land and environment	Opportunities for physical activity are limited, in part, by a lack of usable parks and "green space."	Providing recreational facilities (e.g., basketball courts) at parks and converting vacant lots into "green space" may increase physical activity and strengthen the sense of community.	Increased physical activity, decreased likelihood of disease and health problems related to a sedentary lifestyle.	Acreage of parks People using parks
	Community members may be exposed to physical and environmental hazards when brownfields sites are not cleaned up.	Cleanup activities at brownfields sites and other sites with contaminated land will reduce harmful exposures in the community.	Reduced disease and injury as a result of harmful exposures. Increased opportunity for redevelopment.	Contaminated land
Buildings and infrastructure	Vacant and poorly maintained buildings can expose residents to health hazards and increase the perception of blight in the community.	Redeveloping commercial buildings can create new jobs, and new or renovated housing units can reduce exposures to harmful environmental contaminants (e.g., lead) and improve residents' quality of life.	Decreased exposure to environmental contaminants, physical hazards, and decreased childhood blood lead levels. Reduction in crime and increase in employment.	Commercial properties Number of lead abatements Number of new construction permits Residential properties

health improvements that could potentially result from the redevelopment activities.

Step 4. What data are needed: Can change be measured? The Development Community identified specific indicators that they can track to measure whether change has occurred.

All data collected prior to redevelopment in the 30th Street corridor were considered baseline measures. Development Community members used their expertise to guide the process. For example, local health agency representatives helped identify health benefits and data sources in steps 3 and 4 of the model. Their expertise in health education, risk communication, and data assessment was a valuable asset. To measure changes in the community's health status described by the 19 indicators (step 4 of the model), the

TABLE **2**

Abbreviated Baraboo Action Model

Environment	
Issues	**Measures**
River preservation	Water quality
Pollution of the river	Site inventory Storm water ordinances Pollution prevention practices Sewer system parameters
Sites	Site inventory Status of sites Health consultations/technical assists
Landscape/vegetation	Vegetation survey
Odor/rodents	Odor survey Rodent control data
Habitat concerns	Wildlife survey Environmentally friendly lighting Habitat preservation
Land Use/Reuse	
Issues	**Measures**
Neighborhood design	Sidewalks survey Trails survey Green/open space Businesses/services Design techniques/standards Housing types: pre-1978 housing and commercial units Lead and asbestos remediation Demographics Community pride and satisfaction
Incompatible land uses	Incompatible land use sites
Community-wide employment/business/economic issues	Young families Births College-educated residents Tenants Businesses People shopping/dining Economic statistics School district and real estate data People using parks (young people in the area)
Riverfront access and linkages to complement and connect the downtown square development	River access Trails survey Recreational activities River walk and linkages
Safety/Security/Health	
Issues	**Measures**
Security of worksite during redevelopment	Site access and extra patrol
Poor condition of sidewalks	Sidewalks survey
Security of river trails	Surveillance and accident log
Communication/Risk Communication	
Issues	**Measures**
Continued partnership between city, public health, state, and residents	Partnership activities—city and health outreach activities
Communication of hazards	Partnership activities—number of lead-poisoned children

Development Community selected freely available data sources. These sources of information included community surveys and surveillance reports as well as local, state, and federal Web sites.

The data collection phase of the 30th Street corridor project was completed during summer 2007. ATSDR completed most of the data collection, with the assistance of Development Community members and student volunteers from the University of Wisconsin—Milwaukee. Establishing baseline conditions prior to redevelopment required roughly one full-time and one half-time worker over a period of two months. In other Action Model projects, this work is being shared among members of the Development Community.

The 30th Street corridor pilot project led to the development of community-driven indicators to assess changes in community health status for residents living in or adjacent to the corridor. The Development Community has opted to use the Action Model for redevelopment planning and for tracking indicators over 5–10 years. The project and resulting measurement indicators are described in ATSDR (2008).

Assessing the Utility of the Action Model: Baraboo and Kenosha, Wisconsin

To assess the utility of the Action Model, ATSDR applied it in projects in Baraboo and Kenosha, Wisconsin. The Baraboo project was part of a U.S. EPA–funded brownfields assessment focused on riverfront redevelopment and included a community health monitoring component. We used the Action Model to establish baseline community health indicators. In Kenosha, we applied the Action Model to a community already undergoing redevelopment.

Baraboo, Wisconsin

The Baraboo riverfront redevelopment will directly affect about 500 of Baraboo's 12,000 residents. Through the brownfields assessment process, a Development Community had already formed, and more members joined when the Action Model was proposed during a public outreach session. Using the Action Model, the Baraboo Development Community identified 15 community issues within four public health themes: environment, land use/reuse, safety/security/health,

and communication/risk communication. The Development Community highlighted a range of community issues, such as river preservation and pollution, odor and rodents, neighborhood design, incompatible land uses, and riverfront access, among others. They suggested several redevelopment approaches to address the community issues and described corresponding community health benefits of these approaches. The Development Community created 33 indicators to measure changes in health status, including environmental data, site information, building and business information, park usage data, and many others. The city administrator volunteered to coordinate stewardship to ensure that the Action Model measures would be tracked over time. An abbreviated Action Model, showing the 15 community issues and corresponding 33 measurement indicators, is shown in Table 2. The Action Model project is presented in the report, "Community Health Monitoring: The Baraboo Ringling Riverfront Redevelopment (ATSDR, 2010)." A companion video about the Action Model process is available at www.atsdr.cdc.gov/sites/brownfields/videos/html.

The Baraboo Development Community will use the Action Model as part of efforts to modify the master plan for redevelopment. The Development Community was actively involved in data collection efforts. Some of the measurement indicators will require tracking as frequently as every 6–12 months, while others will be tracked every 2–3 years or longer. Early outcomes from the Baraboo Action Model shown in Table 3 indicate positive changes in about one-third of the 33 community-derived indicators. An example of one such positive change is the 25% reduction in the number of incompatible use sites along the river. Another example is the installation of a stormwater biofiltration pond. Both of these changes can improve environmental quality and reduce potential exposures.

TABLE **3**

Changes in Baraboo Redevelopment Indicators

Measurement Indicator	Measured Change	Summary of Impacts
Site inventory and progress of pollution control, demolition, and remediation measures	Two of 10 brownfield sites relocated and underwent assessment and/or remediation; one site removed physical hazards, such as an abandoned shed and an open trough filled with stagnant water; one site has been through assessment.	√ Greater than 20% reduction of brownfields sites, potential to reduce exposures to contamination or hazards
City ordinances to address storm water management	A biofiltration pond has been constructed.	√ Improve river water quality
Sewer system parameters	Eleven cross connections from the sanitary to storm sewer systems have been repaired.	√ Prevent raw sewage from entering the river
Odor survey of people in a five-block radius of Veolia waste transfer facility regarding odors	The Veolia facility closed and relocated as of June 30, 2010. A site assessment indicated no residual contamination. Odors are no longer present. The lot has been covered with soil fill. Alfalfa to feed local livestock is being grown until the site is redeveloped.	√ Reduction of public health hazards and exposures associated with garbage √ Growing alfalfa contributes to green space, reduces fugitive dust emissions, and provides economical, healthy feed for livestock
Sidewalks survey—number, condition, and extent of sidewalks	Many sidewalk flaws noted during the 2008 survey have been repaired as of June 2010.	√ Sidewalk maintenance improves recreational opportunities and aesthetics
Trails survey	Trail segments were completed, and flood-damaged sections were repaired. The trail was linked to the Ice Age Trail. Trail markers and dog waste receptacles were installed. A dog park was created near the trail.	√ Increased opportunities for recreation with associated health benefits √ Dog waste receptacles prevent pet waste from impacting the river or people
Number and types of incompatible land uses	As of June 2010, two of eight incompatible facilities (Veolia and Alliant) were relocating away from the riverfront. As of June 2012, a third incompatible facility went through full assessment and closure.	√ Greater than 25% decrease in incompatible land uses, potential to reduce exposures to contaminants or hazards
Baraboo River access	June 2010 observations showed heavy use of the river at Kiwanis Gazebo Park.	√ Increased opportunities for recreation and aesthetic enjoyment
Surveillance of recreational activities along Riverwalk Trail and linkages to the downtown square	August 2009, June 2010, and August 2010 observations indicated increased trail use. The redevelopment area is linked by sidewalks and parking lots, with ample access provided to the Riverwalk Trail.	√ Increased recreational amenities and a walkable community, with potential to reduce obesity and reduce reliance on automobiles

Kenosha, Wisconsin

The Kenosha Brass site is a 29-acre urban brownfields site that was partially redeveloped in 2009. The city of Kenosha provided ATSDR with "before and after" data from 2001–2006, and we fit these data to the Action Model. The city targeted the residential neighborhoods surrounding the Brass site. Community involvement efforts resulted in the construction of 20 affordable single family homes and the demolition of eight blighted properties. A full-service grocery store, a bank, and a middle school have been constructed through this effort, and construction continues on a mixed-use building. The Action Model framework shown in Table 4 summarizes the city-pro-

TABLE **4**

Kenosha Brass Site: Agency for Toxic Substances and Disease Registry Brownfields/Land Revitalization Action Model Assessment

What Are the Community Issues?	How Can Redevelopment Address the Issues?	What Is the Corresponding Health Benefit?	What Measurement Is Required (Indicator)? Baseline, 2001	What Measurement Is Required (Indicator)? Midway Through Redevelopment, 2006
Need low- to moderate-income housing; some properties need minor or major repair; need to increase homeowner occupancy	Build low- to moderate-income homes around the Brass site; build mixed-use residential facilities on the site; provide no-interest loans for infrastructure repair	Prevent gentrification and loss of neighborhood; increase owner-occupancy; increase property values, increase community pride	Neighborhood diverse; properties: 60 buildings; 43 minor repairs; 17 major repairs; 31 owner occupied; 29 tenant occupied	Neighborhood diverse; properties: 73 buildings; 67 minor repairs; 6 major repairs; 50 owner occupied; 23 tenant occupied
Need a new grammar school	Build a school on Brass site	Access to education; walk to school	No school on site	School is completed (2009)
High crime area	Improve housing, remove blighted structures	Increased safety and security	328 crime calls	164 crime calls
Closest full-service grocery store 15 blocks away	Build a full-service grocery store on Brass site	Access to healthy food, potentially leading to improved health status	No grocery store within 15 blocks	Full-service grocery store opened on site, during development

vided data, along with community issues and the city's redevelopment approaches.

Since the development of new homes and removal of blighted properties, home ownership in neighborhoods surrounding the Brass site increased, and crime rates dropped almost 50%. In addition, from 2001 to 2006, the average assessed value of residential property increased from about $70,000 to over $100,000 (Khaligian, 2006). The Kenosha example demonstrated that the Action Model can be used in situations in which redevelopment is well under way and not only in predevelopment conditions.

The Utility of the Action Model

The Action Model is useful for assessing the effects of brownfields on overall community health status. It creates community-driven indicators to measure these effects. The Action Model can be implemented in densely populated urban areas, such as Milwaukee's 30th Street corridor or in more rural, smaller redevelopment projects such as the Baraboo riverfront. The Action Model was created to allow assessment of baseline community health status prior to redevelopment. It may also be useful for communities that are already redeveloping, like Kenosha, provided there is availability of such baseline characteristics as property values or crime statistics.

A diverse Development Community engaged in the Action Model framework creates a climate in which people work together to develop public health indicators and plan for healthy redevelopment. While it takes time, perhaps years, to see the effects of such efforts, the Action Model, through its focus on improving overall health status and creating partnerships, may provide ideas for change for communities adversely affected by brownfields.

Since its use in the Milwaukee and Baraboo projects, the ATSDR Brownfields/Land Revitalization Action Model has been used by communities in Detroit, Michigan; Minneapolis, Minnesota; East Cleveland, Ohio; Portland, Oregon; Blue Island, Illinois; Janesville, Ohio; and Rochester, Albany, and Utica, New York; among others. Projects undertaken in these communities are leading to the development of a common core set of brownfields/land reuse public health indicators that may broadly be applied by other communities. More information about the Action Model is available at www.atsdr.cdc.gov/sites/brownfields/model.html.

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Public Health Department Accreditation and Environmental Public Health: Sustaining the Collaboration

Editor's Note: NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature a column from the Environmental Health Services Branch (EHSB) of the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In this column, EHSB and guest authors from across CDC will highlight a variety of concerns, opportunities, challenges, and successes that we all share in environmental public health. EHSB's objective is to strengthen the role of state, local, tribal, and national environmental health programs and professionals to anticipate, identify, and respond to adverse environmental exposures and the consequences of these exposures for human health.

The conclusions in this article are those of the author(s) and do not necessarily represent the views of CDC.

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The first national voluntary accreditation program for public health departments was launched in September 2011 (Public Health Accreditation Board [PHAB], 2011a). The first cohort of public health departments was accredited in February 2013. The Centers for Disease Control and Prevention (CDC) and the Robert Wood Johnson Foundation cofunded the national accreditation program's development and startup. The Public Health Accreditation Board (PHAB) manages the program and grants accredited status. PHAB evaluates applicants' conformity with established standards and measures. The standards and measures are divided into 12 domains: one domain for each of the 10 essential public health services, plus domains for public health department administration and public health governance (PHAB, 2011b). The overall goal of accreditation is to advance the quality and performance of public health departments.

Collaboration between PHAB and its critical partners and constituencies, including the CDC National Center for Environmental Health and other environmental public health (EPH) professionals, has been an important aspect of developing the new program. Key recommendations from early collaboration between PHAB and EPH professionals included consistently and accurately using EPH terminology; including EPH expertise when site review teams are selected; identifying areas for EPH documentation in PHAB submissions; and continual, consistent EPH participation throughout the accreditation process (Blake, Corso, & Bender, 2011).

EPH is expected to be a major contributor to the accreditation process and many PHAB standards and measures specifically involve EPH. PHAB site visitors expect to see evidence of EPH activities even if a public health department does not have statutory EPH authority and responsibilities. To gain insight on EPH contributions during accreditation processes, we reached out to recently accredited public health departments and PHAB site visitors who have EPH expertise. These discussions revealed several common themes and lessons learned as follows:

- EPH plays a significant role with Domain 2 (investigations), Domain 5 (policies and plans, including emergency preparedness), and Domain 6 (enforcement). EPH contributions are not limited to these domains, however. For example, one recently accredited health department was able to demonstrate conformity with Domain 3 measures by providing documentation of culturally and linguistically appropriate education via Spanish-language food handlers' courses.
- EPH involvement is not limited only to domains where EPH documentation will be submitted. EPH staff can contribute to the review of other documentation and provide an EPH perspective across all 12 domains, which can lead to a more collaborative approach to the accreditation process.

- EPH can have an active role in prerequisite activities such as community health assessment, community health improvement planning, and strategic planning. Several recently accredited health departments relied heavily on EPH indicators and participation in the community health assessment and improvement planning process. EPH participation in health department strategic planning is largely dependent on whether EPH is housed within a separate agency or agencies.
- Documentation is the key to a successful accreditation process. Staff at several recently accredited health departments commented on the importance of updated policies and plans to demonstrate conformity with PHAB measures. EPH contributions to documentation, such as inspection and investigation reports, work particularly well for accreditation purposes because they are typically recorded on official templates with signature and date. Staff at one recently accredited health department pointed out that documentation of a routine activity, such as inspecting food vendors at a large public event, is just as important as documenting an investigation.
- Incorporating the 10 essential public health services and the related 10 essential environmental public health services into EPH department operations may increase accreditation readiness. Use of the Environmental Public Health Performance Standards (EnvPHPS) is one way EPH departments can assess their level of essential service incorporation. More information about EnvPHPS can be found at www.cdc.gov/nceh/ehs/envphps/ (Centers for Disease Control and Prevention, 2011).
- EPH services are not always provided by the health department itself. It is important to identify all agencies contributing to the EPH system (e.g., environmental quality or agriculture departments) for participation in the accreditation process.
- Pursuing accreditation can lead to institutionalized changes in policies and procedures. Accreditation team members at one recently accredited health department shared their experience with determining whether their policies were "best" or just "existing." At another recently accredited health department, staff found that changes in animal bite reporting prompted by the accreditation process have led to improved analysis of bite trends by time and location, resulting in more effectively targeted preventive measures across the jurisdiction.
- Involvement with accreditation can lead to fundamental changes in the way EPH conducts business both at the health department and within the public health system. As an example, one recently accredited health department was able to identify and close an information-sharing gap between the health department and another department that manages most EPH activities in the jurisdiction. Collaboration during the accreditation process resulted in the two departments working more closely together to meet the community's EPH needs.

EPH professionals fulfill key roles in the accreditation process, both by participating in the pursuit of accreditation and by serving as PHAB site visitors. All health department staff and site visitors who responded to the request to participate in the development of this article found their accreditation efforts to be rewarding and beneficial to both the health department and the community. One health department's accreditation coordinator commented, "What we've gotten back has been not only the accreditation and recognition of that status but also improvements in processes, procedures, and service to the community." Another remarked, "In the big picture, it's more about continuing to improve services."

EPH professionals are strongly encouraged to support collaboration through engaging in the accreditation process or serving as a site visitor. To learn more about accreditation and how EPH can contribute, visit the PHAB Web site (www.phaboard.org).

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The First 11 Health Departments to Receive Five-Year Public Health Accreditation Board Accredited Status

- Comanche County Health Department (Lawton, OK)
- Franklin County Health Department (Frankfort, KY)
- Livingston County Department of Health (Mt. Morris, NY)
- Northern Kentucky Independent District Health Department (Edgewood, KY)
- Oklahoma City-County Health Department (Oklahoma City, OK)
- Oklahoma State Department of Health (Oklahoma City, OK)
- Spokane Regional Health District (Spokane, WA)
- The Public Health Authority of Cabarrus County, Inc., d/b/a Cabarrus Health Alliance (Kannapolis, NC)
- Three Rivers District Health Department (Owenton, KY)
- Washington State Department of Health (Olympia, WA)
- West Allis Health Department (West Allis, WI)

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DEMYSTIFYING THE FUTURE

Thomas Frey

The Rise of the City: A Look at Cities in a Century

Editor's Note: Significant and fast-paced change is occurring across society in general and our profession in particular. With so much confusion in the air, NEHA is looking for a way to help our profession better understand what the future is likely to look like. The clearer our sense for the future is, the more able we are to both understand and take advantage of trends working their way through virtually every aspect of our lives today. To help us see what these trends are and where they appear to be taking us, NEHA has made arrangements to publish the critical thinking of the highly regarded futurist, Thomas Frey.

The opinions expressed in this column are solely that of the author and do not in any way reflect the policies and positions of NEHA and the *Journal of Environmental Health*.

Thomas Frey is Google's top-rated futurist speaker and the executive director of the DaVinci Institute®. At the Institute, he has developed original research studies enabling him to speak on unusual topics, translating trends into unique opportunities. Frey continually pushes the envelope of understanding, creating fascinating images of the world to come. His talks on futurist topics have captivated people ranging from high-level government officials to executives in Fortune 500 companies. He has also authored the book *Communicating with the Future*. Frey is a powerful visionary who is revolutionizing our thinking about the future.

What do you think will be the most powerful entity in the world 100 years from now?

As we look around us today, it's easy to point to a single nation as being the most powerful. But will that still be true 100 years from now?

The most powerful entities in the future could be large multinational corporations, giant associations of people or companies, religious groups, clusters of countries such as the North Atlantic Treaty Organization, perhaps some new entity that controls technology like the Internet Corporation for Assigned Names and Numbers, or something else entirely?

Adding to the confusion of this question, what actually defines power? Is it money, clout, influence, an ability to control a large military, or some combination of all of these?

Will the notion of power be defined differently in the future than it is today?

These are all important questions to ask because powerful entities define the powerful people. And it is the underlying systems and technology that will determine status and clout.

Caught in the middle of all this influence-wrangling is the lowly city, an entity now subservient to states and countries and often lost in the commerce of daily life. Are cities likely to remain at the lower end of the clout spectrum, or is some new kind of power shift afoot?

Here are a few thoughts about the rising influence of cities that may surprise you.

Demographic Shifts

Today, roughly 498 metro areas in the world have over one million residents. According to the Martin Prosperity Institute, the world's top 100 cities alone generate half of the world's total economic output.

The world population has experienced continuous growth since the end of the Great Famine and the Black Death in 1350, when it stood at around 370 million.

As recently as 1800, only 3% of the world population lived in cities. By 2011, that number had risen to over 50% and projections show the urbanization trend will climb to over 70% by 2025.

Cities have a disproportionate impact on global science research and innovation. They are often home to top colleges, government institutions, and research facilities. As in other fields, top researchers are drawn to cities for the opportunities to associate and collaborate with other leading scientists and institutions.

As an example, Beijing and Sao Paulo each contribute more than 20% of the annual production of peer-reviewed science publications in China and Brazil, respectively. Moscow accounts for more than 50% of Russian science articles.

Seeking the Greatest Imbalance

Cities are very competitive. They compete for businesses, air traffic, tourists, conventions, sporting events, grants, talent, and media coverage.

Most are heavily invested in the rankings by major media outlets that show how they measure up against other municipalities with similar attributes.

Any city that demonstrates a successful new piece of infrastructure, attracts a major retail store, or builds a new library, airport, or convention center is quickly copied by other cities.

This constant effort to achieve parity or balance with other cities is missing the true potential for achieving a radical imbalance.

In the end, having the most well-balanced, well-functioning city means very little on a world stage where people only take notice of the anomalies.

Great cities are never well balanced. They only become great because of some huge imbalance.

Houston is well known because it is disproportionately weighted towards the oil industry. Los Angeles is famous because it is overly focused on Hollywood and the entertainment industry. New York, London, and Beijing all have an unusual emphasis on money and finance. And San Francisco has developed an extraordinary emphasis on the tech industry.

Amassing Talent Clusters

Once a minor imbalance has been achieved, a city can begin to attract the talent needed to perpetuate this unevenness.

According to Richard Florida, author of *The Rise of the Creative Class*, "Creative individuals want to live in places that protect personal freedoms, prize diversity, and offer an abundance of cultural opportunities. With the possible exception of Hong Kong, Asia's cities still lack this level of openness and attractiveness, even though six of the top 10 economic powers are in Asia—Tokyo, Singapore, Hong Kong, Shanghai, Beijing, and Seoul."

The key to global competitiveness lies in a city's ability to attract the best and brightest from every corner of the globe. In our increasingly mobile society, these kinds of population shifts will become much more common.

Thoughts on the Honduras Private City Proposal

In September 2012, the Honduran government voted to allow for the creation of private cities, each with their own judiciary, laws, governments, and police forces. They would have also been empowered to sign international agreements on trade and investment and set their own immigration policy.

Driving the proposal was the U.S.-based investment group MGK, who was willing to invest $15 million to begin building basic infrastructure for the first model city near Puerto Castilla on the Caribbean coast. They estimated the first city would create 5,000 jobs over the first six months and up to 200,000 jobs in the future.

The Honduran Supreme Court ruled the project unconstitutional, however. By a 13–1 vote, its supreme court judges decided that the proposal violated the principle of sovereignty.

In this small country, with an average annual income of $4,400 and riddled with crime and corruption, the private city proposal was viewed as a quick fix for its current problems.

While this idea may have been fueled by good intentions, a quick fix seldom exists for bad government.

Final Thoughts

Cities matter.

While cities are limited by their geographic boundaries, the physical borders do not limit their global clout and influence.

As living, breathing organisms, cities are better positioned to experiment and take advantage of their regional differences. While countries may come and go, cities remain as long-term entities that will survive and thrive into the distant future.

With transportation becoming easier, making us a more mobile society, and with cell phones and the Internet speeding up our digital communications, our cities are becoming a more fluid environment.

Much like water that flows downhill using the path of least resistance, businesses and social structures have begun to move from areas we find less appealing to areas that are more appealing.

Future cities will be designed around fresh new ways for people to meet people, and they will be judged by their vibrancy, their interconnectedness, and their fluid structures for causing positive human collisions.

Going back to my original question, the most powerful entity in the world 100 years from now will not likely be an individual city. That entity will be headquartered in a city, however, and the symbiotic relationship between that organization and its host city will be a major contributing factor.

Interested in sharing your thoughts? Go to www.FuturistSpeaker.com.

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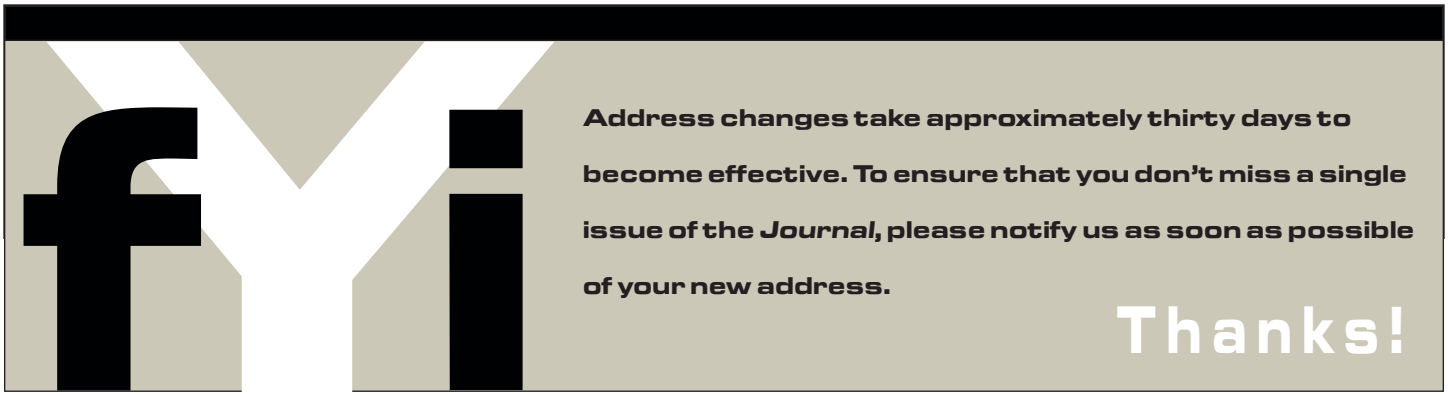


CAREER OPPORTUNITIES

Food Safety Inspector

Everclean Services is the leader in the restaurant inspections market. We offer opportunities throughout the country. We currently have openings for professionals to conduct Q.A. audits of restaurants.

Alaska	Mobile, AL
Albuquerque, NM	New Orleans, LA
Baton Rouge, LA	Pittsburgh, PA
Buffalo, NY	Richmond, VA
Butte, MT	Rochester, NY
Cleveland, OH	Rogers, AR
Jacksonville, FL	Spearfish, SD
Little Rock, AR	Virginia Beach, VA
McAllen, TX	Washington, DC

Past or current food safety inspecting is required.
Interested applicants can send their resume to: Bill Flynn at Fax: 818-865-0465. E-mail: bflynn@evercleanservices.com.

EH CALENDAR

UPCOMING NEHA CONFERENCES

July 9–11, 2013: Hyatt Regency Crystal City at Reagan National Airport, Washington, DC, Area. For more information, visit www.neha2013aec.org.

NEHA AFFILIATE AND REGIONAL LISTINGS

Alaska
October 2–4, 2013: 2013 Annual Educational Conference, sponsored by the Alaska Environmental Health Association, https://sites.google.com/site/aehatest/.

Colorado
September 25–27, 2013: 2013 Annual Education Conference & Exhibition, sponsored by the Colorado Environmental Health Association, www.cehaweb.com/aec.html.

Florida
September 5–6, 2013: Annual Education Conference, sponsored by the Florida Environmental Health Association, www.feha.org.

Maryland
July 24–26, 2013: 67th Annual Interstate Environmental Health Seminar, hosted by the Maryland Environmental Health Association, www.wvdhhr.org/wvas/IEHS/index.asp.

Missouri
October 2–4, 2013: Annual Education Conference, sponsored by the Missouri Environmental Health Association, www.mmfeha.org.

Montana
October 8–9, 2013: 2013 Fall Educational Conference, "Partnering for Health Change," sponsored by the Montana Environmental Health and Public Health Associations, www.mehaweb.org.

Nevada
July 23–25, 2013: Annual Educational Conference, sponsored by the Nevada Environmental Health Association, www.nveha.org/conf_reg_2013.html.

Rhode Island
September 25–26, 2013: 51st Annual Yankee Conference, hosted by the Rhode Island Environmental Health Association, www.ehari.org.

Texas
October 8–12, 2013: 58th Annual Education Conference, sponsored by the Texas Environmental Health Association, www.myteha.org/Annual_Education_Conference.

Wisconsin
September 25–26, 2013: Joint Regional Education Conference, presented by the environmental health association affiliates from Wisconsin, Minnesota, Iowa, Nebraska, North Dakota, and South Dakota, www.weha.net.

Wyoming
October 8–10, 2013: 2013 Annual Education Conference, sponsored by the Wyoming Environmental Health Association and the Wyoming Food Safety Coalition, www.wehaonline.net.

TOPICAL LISTINGS

Geospatial Technologies
August 25–29, 2013: 2nd Symposium on Advances in Geospatial Technologies for Health, sponsored by the International Society for Photogrammetry and Remote Sensing Working Group on Health, www2.isprs.org/commissions/comm8/wg2/symposium.html.

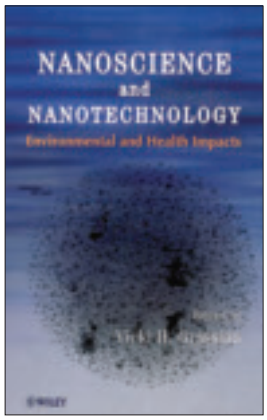
RESOURCE CORNER

Resource Corner highlights different resources that NEHA has available to meet your education and training needs. These timely resources provide you with information and knowledge to advance your professional development. Visit NEHA's online Bookstore for additional information about these, and many other, pertinent resources!

NEHA BOOKSTORE
www.neha.org/store

Nanoscience and Nanotechnology: Environmental and Health Impacts

Edited by Vicki H. Grassian (2008)



As more and more nanomaterials are developed and more and more applications for nanomaterials are discovered, questions about how these materials affect the environment and human health are becoming increasingly urgent. With articles contributed by leading researchers, this book examines the results of recent scientific studies that have begun to provide answers to these very important questions. These answers, in turn, will help shape sound environmental policies that will permit the continued growth of nanoscience and nanotechnology. With the number of nanotechnology-based products expected to grow substantially in the near future and beyond, researchers and regulators should turn to this book for help in addressing the many questions concerning the impact of nanoscience and nanotechnology on health and the environment.

469 pages / Hardback / Catalog #1112
Member: $107 / Nonmember: $112

Bed Bug Handbook: The Complete Guide to Bed Bugs and Their Control

L.J. Pinto, R. Cooper, and S.K. Kraft (2007)

The *Bed Bug Handbook* is a complete and up-to-date guide to bed bugs and their control. It includes sections on the history and impacts of bed bugs, their biology and habits, how bed bugs spread, and medical and social considerations of bed bug infestations. The largest portion of the book consists of practical step-by step guidance for preventing bed bug infestations and for dealing with bed bug outbreaks. There is an extensive section on bed bug inspections. The book includes checklists for preventing and controlling bed bugs in specific kinds of facilities, such as apartments, hotels, medical facilities, and furniture rental warehouses.

266 pages / Paperback / Catalog #1037
Member: $66 / Nonmember: $69

Designing Healthy Communities

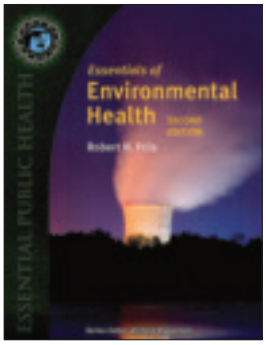
Richard J. Jackson with Stacy Sinclair (2012)

This book highlights how we design the built environment and its potential for addressing and preventing many of the nation's devastating childhood and adult health concerns. The author looks at the root causes of our malaise and highlights healthy community designs achieved by planners, designers, and community leaders working together. Ultimately, the author encourages all of us to make the kinds of positive changes highlighted in this book.

230 pages / Hardback / Catalog #1122
Member: $48 / Nonmember: $52

Essentials of Environmental Health (Second Edition)

Robert H. Friis (2010)



This book provides a clear and comprehensive study of the major topics in environmental health including 1) background on the field and tools of the trade (environmental epidemiology, environmental toxicology, and environmental policy and regulation); 2) environmental diseases (microbial agents and ionizing and nonionizing radiation); and 3) applications and domains of environmental health (water and air quality, food safety, waste disposal, and occupational health). The second edition is a thorough revision that includes new material such as a chapter on injuries, an expanded discussion of the history of environmental health, a case study on pandemic influenza (H1N1) in 2009, and coverage of environmental controversies.

442 pages / Paperback / Catalog #1115
Member: $90 / Nonmember: $97

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2	**Blando, James D., MHS, PhD, et al.** Lead-Based Paint Awareness, Work Practices, and Compliance During Residential Construction and Renovation	75.9 May 2013 Pages: 20–27	Children's Environmental Health	Lead	Occupational Health/Safety	Public Health/ Safety	
3	**Boraiko, Carol, MS, PhD, et al.** Lead Contamination of Paint Remediation Workers' Vehicles	75.7 March 2013 Pages: 22–27	Children's Environmental Health	Lead	Occupational Health/Safety		
4	**Borchgrevink, Carl P., PhD, et al.** Hand Washing Practices in a College Town Environment	75.8 April 2013 Pages: 18–24	Institutions and Schools	Occupational Health/Safety	Public Health/ Safety	Risk Assessment	
5	**Brondum, Jack, DVM, PhD, et al.** Energy Conservation Awareness and Practice in Restaurants of Hennepin County, Minnesota	75.5 Dec 2012 Pages: 8–12	Ambient Air	Food	Meteorology/ Weather/ Climate	Sustainability	
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35	**Reames, Ginger, et al.** Lead Detection in Food, Medicinal, and Ceremonial Items Using a Portable X-Ray Fluorescence (XRF) Instrument	75.6 Jan 2013 Pages: 16–20	Children's Environmental Health	Food	Hazardous Materials/Toxic Substances	Lead	Risk Assessment
36	**Rincón-Bedoya, Elizabeth, PhD, et al.** Mutagenicity and Genotoxicity of Water Treated for Human Consumption Induced by Chlorination By-products	75.6 Jan 2013 Pages: 28–36	Drinking Water	Hazardous Materials/Toxic Substances	International		
37	**Roberts, Jennifer D., MPH, DrPH, et al.** Wind Turbines: Is There a Human Health Risk?	75.8 April 2013 Pages: 8–17	Community Nuisances/ Safety	Noise	Risk Assessment	Sustainability	
38	**Ryan, Patrick H., PhD, et al.** A Community-Based Participatory Research Partnership to Reduce Vehicle Idling Near Public Schools	75.9 May 2013 Pages: 14–19	Ambient Air	Children's Environmental Health	Education	Institutions and Schools	Public Health/ Safety
39	**Ryan, Timothy J., PhD, CIH, CSP, et al.** Community-Associated Methicillin-Resistant *Staphylococcus aureus* in College Residential Halls	75.6 Jan 2013 Pages: 44–49	Emerging Pathogens	Institutions and Schools	Microbiology	Public Health/ Safety	
40	**Saha, Ratul, PhD, et al.** Are We Aware of Microbial Hotspots in Our Household?	75.2 Sept 2012 Pages: 12–19	Microbiology				

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41	**Sharkey, Kenneth W., MPH, RS, et al.** An Investigation to Determine Association Between Foodborne Illness and Number of Citations in a Food Establishment	75.2 Sept 2012 Pages: 8–11	Food				
42	**Smith, Christopher T., REHS, MPH, DAAS** Environmental Health in the South Pacific	75.5 Dec 2012 Pages: 28–29	Disaster/ Emergency Response	Education	General		
43	**Smith, Kathleen A., MPH, DVM, RS, et al.** Complaints Associated With Animal Feeding Facilities as Reported to Ohio Local Health Departments, 2006–2008	75.9 May 2013 Pages: 8–13	Ambient Air	Community Nuisances/ Safety	Public Health/ Safety		
44	**Spear, Terry M., PhD, et al.** The Presence of Asbestos-Contaminated Vermiculite Attic Insulation or Other Asbestos-Containing Materials in Homes and the Potential for Living Space Contamination	75.3 Oct 2012 Pages: 24–29	Hazardous Materials/Toxic Substances	Indoor Air	Public Health/ Safety		
45	**Swistock, Bryan R., MS, et al.** Water Quality and Management of Private Drinking Water Wells in Pennsylvania	75.6 Jan 2013 Pages: 60–66	Drinking Water	Water Pollution Control/Water Quality			
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47	**Wang, Vincent J., MD, MHA, et al.** Altitude and Environmental Climate Effects on Bronchiolitis Severity Among Children Presenting to the Emergency Department	75.3 Oct 2012 Pages: 8–15	Children's Environmental Health	Meteorology/ Weather/ Climate			
48	**Waters, A. Blake, MPH, PhD, LEHS, et al.** Impact of Internet Posting of Restaurant Inspection Scores on Critical Violations	75.10 June 2013 Pages: 8–12	Food	Management/ Policy	Public Health/ Safety	Technology	
49	**Whittaker, Stephen G., PhD, et al.** A Health and Environmental Profile of the Dry Cleaning Industry in King County, Washington	75.10 June 2013 Pages: 14–22	Hazardous Materials/Toxic Substances	Occupational Health/Safety			
50	**Wilson, Denise, MEd, PhD, et al.** Arsenic and Lead in Juice: Apple, Citrus, and Apple-Base	75.5 Dec 2012 Pages: 14–20	Children's Environmental Health	Drinking Water	Hazardous Materials/Toxic Substances	Lead	
51	**Wiznia, Daniel H., MD, et al.** The Use of Deer Vehicle Accidents as a Proxy for Measuring the Degree of Interaction Between Human and Deer Populations and Its Correlation With the Incidence Rate of Lyme Disease	75.8 April 2013 Pages: 32–39	Emerging Pathogens	Epidemiology	Microbiology	Public Health/ Safety	Vector Control
52	**Yeager, Valerie A., MPH, MPhil, DrPH, et al.** Relationship Between Food Safety and Critical Violations on Restaurant Inspections: An Empirical Investigation of Bacterial Pathogen Content	75.6 Jan 2013 Pages: 68–73	Food	Public Health/ Safety			
53	**Yost, Christopher K., PhD, et al.** Prevalence of Methicillin-Resistant Staphylococci Species Isolated From Computer Keyboards Located in Secondary and Postsecondary Schools	75.6 Jan 2013 Pages: 50–58	Emerging Pathogens	Institutions and Schools	International	Microbiology	Public Health/ Safety

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JEH QUIZ

FEATURED ARTICLE QUIZ #1

Baseline Knowledge Survey of Restaurant Food Handlers in Suburban Chicago: Do Restaurant Food Handlers Know What They Need to Know to Keep Consumers Safe?

Available to those holding an Individual NEHA membership only, the *JEH* Quiz, offered six times per calendar year through the *Journal of Environmental Health,* is a convenient tool for self-assessment and an easily accessible means to accumulate continuing-education (CE) credits toward maintaining your NEHA credentials.

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→ Quiz deadline: October 1, 2013

1. According to the Centers for Disease Control and Prevention, a reduction of foodborne illness by only 10% would keep __ million Americans from getting sick each year.
   a. one
   b. two
   c. five
   d. seven
2. It is estimated that __ million illnesses and __ deaths can be attributed to the consumption of food.
   a. 48; 868
   b. 48; 3,000
   c. 52; 868
   d. 52; 3,000
3. According to the Food and Drug Administration, the most common food handler behaviors contributing to foodborne outbreaks include
   a. poor hand hygiene.
   b. cross contamination.
   c. improper temperatures for cooking and holding food.
   d. all of the above.
   e. a and c.
4. In a recent study, approximately __ of food handlers did not change gloves between touching raw meat and ready-to-eat food.
   a. one-fourth
   b. one-third
   c. one-half
   d. two-thirds
5. Of the food handlers surveyed in this article, the overall mean knowledge score was __.
   a. 65%
   b. 72%
   c. 75%
   d. 79%
6. In looking at the different classifications of food handlers surveyed, noncertified food handlers scored __ compared to __ scored by certified food managers.
   a. 65%; 75%
   b. 65%; 79%
   c. 75%; 65%
   d. 75%; 79%
7. Certified food managers in Illinois are required to renew their certification after five years.
   a. True.
   b. False.
8. Fewer than __ of certified food managers were able to correctly answer questions about internal cooking temperatures for hamburger/chicken and the range of the temperature danger zone at which pathogens proliferate.
   a. two-thirds
   b. one-half
   c. one-third
   d. one-fourth
9. The survey question that was answered correctly by the lowest number of overall food handlers pertained to the
   a. pathogen growth temperature danger zone.
   b. acceptable minimum hamburger cooking temperature.
   c. proper thawing procedure for chicken.
   d. storage of food products with expiration dates.
10. Food handlers with English as their primary language scored __ those with Spanish as their primary language or other languages.
    a. lower than
    b. the same as
    c. higher than
11. Which age group of food handlers scored the lowest on the survey?
    a. 18–29 years.
    b. 30–39 years.
    c. 40–49 years.
    d. ≥50 years.
12. __ percent of food handlers surveyed indicated that they would come to work with diarrhea.
    a. Ten
    b. Seventeen
    c. Twenty-four
    d. Thirty-two

JEH Quiz #5 Answers
March 2013

1. b	4. e	7. d	10. a
2. d	5. c	8. a	11. b
3. a	6. a	9. b	12. a

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NEHA **NEWS**

Providing Resources to Environmental Health Professionals in Developing Countries

For several years now and largely through the efforts of NEHA First Vice President Bob Custard, many environmental health resource books have been donated to environmental health colleagues in developing countries in Africa. In 2008, NEHA shipped several boxes of slightly outdated (but still relevant and useful) books from NEHA's office library to the Environmental Health Support Association–Uganda (EHSA-U). The donated books from NEHA were used by EHSA-U to start a small environmental health library, named in honor of NEHA's Executive Director, Nelson Fabian, who authorized that first shipment. More recently, in 2010, Custard traveled to Uganda where he participated in the dedication of the library on behalf of NEHA. Custard also went to Zambia on that trip in an effort to provide some assistance to environmental health professionals in that country as well.

Earlier this year the Arizona Environmental Health Association (AZEHA) contacted Custard; AZEHA was closing the doors on its lending library of environmental health resources and wanted to know if Custard had any interest in these books. Of course Custard did, and three boxes of books were sent to him (two from AZEHA and one donated personally by Tom Dominick, past AZEHA president).

In June, some of the books were delivered to the EHSA-U. In July, some of the books were given to representatives from developing countries who attended NEHA's 2013 Annual Educational Conference & Exhibition in Washington, DC. And lastly, some of the books will be heading to Zambia in August and will be donated to the Zambian Institute of Environmental Health.

NEHA commends and thanks Custard for all his hard work in providing fellow environmental health professionals with these much needed resources over the past years. A large thank-you goes out to the AZEHA for donating their library to an amazing cause, as well as to all those who have donated books in the past or have travelled to Africa to deliver these resources. "You have made a huge difference for environmental health colleagues facing enormous challenges with few resources," stated Custard.

Managing Editor's Desk

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take in the enormity of what I just wrote. It's mind-boggling.)

To be employable is to be of value. To have value to an employer, one needs to be relevant, which in turn means that one has to have an always growing knowledge of the factors that pertain to one's line of work. Given how quickly old knowledge becomes outdated, lifelong learning becomes essential. And by lifelong learning, I'm not talking about looking something up on the Internet! I'm talking about serious study that involves a more in-depth comprehension of an issue.

Helping this process along is technology. One of the best examples of that is online education. In fact, the phenomenal rise of MOOCs (massive open online courses) is being hailed by some as an evolutionary successor to the colleges and universities of today. iTunes University, which is one of my favorite online learning sites, just announced that it had its one billionth download of a course. That too is astounding!

Mark my words. As more and more employers come to accept learning experiences from MOOCs, the value of a college degree—and especially an older degree—is going to go down.

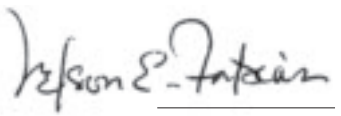
While access to learning can indeed be facilitated by the growing volume of courseware now appearing online, let me make one huge point: *for learning to be valuable, it has to be credible.* As is often said, the Internet is akin to the Wild West where few rules exist and credible material is often hard to find. Moreover, finding the exact material and/or answers that one is looking for too often plays out as an exasperating and unsuccessful search mission. This is where professional societies like NEHA come into play.

Professional associations represent the number-one source for continuing education in America. Whether it's through our annual conference, our extensive library of online learning courses, or just the material that we publish on our Web site, it is our job to understand your world and more importantly, what you need to know to keep pace with the rapidly occurring change taking place all around you.

NEHA can't guarantee job security but by gosh, we play a crucial role in identifying the issues that you need to know and then providing you with various (and credible) ways to learn that knowledge. In fact, the entire premise of an organization like ours centers on lifelong learning. With the invaluable help of many practicing professionals, we design and produce credible education to provide the practitioners of this profession the knowledge that they need for this world … and the ones likely to evolve from it.

As I have often asserted in the pages of this column, even if we wanted to, we are not going to turn the clock back to some golden age of environmental health. In fact, our mission points us in the exact opposite direction, as it stresses "advancement." NEHA's mission is to advance you into the world of tomorrow in ways that equip you with the knowledge you need in order to be successful and to achieve the environmental health goals our work can realize.

Seen against the backdrop of a fast-moving world that requires us to be lifelong learners to keep pace and to maintain our value and employability, I can think of no career security investment that one could make that beats a membership in a professional society. And I say that as a card-carrying and dues-paying member of several!



nfabian@neha.org

VIRTUAL AEC

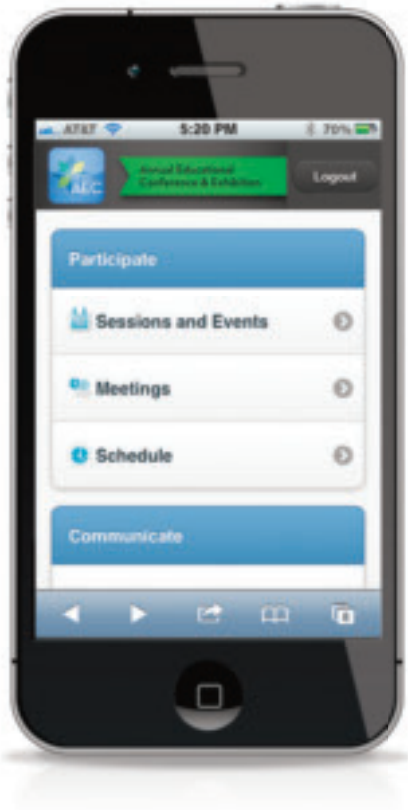
Access Valuable Educational Content
from the NEHA 2013 AEC

NEHA AEC 77th

Though the NEHA 2013 AEC has ended in Washington, DC, you can still access valuable educational content from this event using the Virtual AEC. The Virtual AEC provides you with:

- An archive of 25 educational sessions that were recorded live from Washington, DC, which can now be viewed on demand
- Access to speaker presentations, handouts, and other materials
- The opportunity to earn continuing education credits
- A way to connect to a professional network of environmental health professionals, speakers, and exhibitors that attended the AEC

Whether or not you attended the NEHA 2013 AEC in Washington, DC, the Virtual AEC serves as an important resource for you to review valuable educational content over and over again, and to continue networking and conversing with other professionals!



Visit neha2013aec.org for more information.

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78th NEHA AEC

IN PARTNERSHIP WITH THE IFEH 13TH WORLD CONGRESS

NEHA 2014 AEC
CALL FOR ABSTRACTS

The National Environmental Health Association presents its 78th Annual Educational Conference & Exhibition in Las Vegas, NV, July 7-10, 2014.

The NEHA AEC is designed to train, educate, and advance people who have an interest or career in environmental health and protection, as well as to bring people together to build a professional network of environmental health colleagues, exchange information, and discover new and practical solutions to environmental health issues.

AEC Format

Directed and sequenced programming will be presented in simultaneous training and educational tracks. NEHA is seeking abstracts that bring to a national and international audience the latest advances in environmental health, as well as unique responses to environmental health and protection problems. Practical applications in both the public and private sectors should be emphasized along with the latest in proven emerging technologies.

NEHA offers two different types of training and educational sessions at the AEC—the Lecture and the Learning Lab. For Lectures, applications for single or multiple speaker presentations that are educational in nature are being accepted. However, presentations that are more interactive will be given first consideration. For Learning Labs, NEHA is accepting applications for hands-on demonstrations, tabletop exercises, poster presentations, drop-in learning labs, roundtable discussions, and other types of interactive and innovative presentation formats that will help train the attendees.

Ensuring Attendees a Return on Investment

Additionally, the NEHA AEC is being rationalized according to return on investment (ROI) principles. Emphasis will be given to those abstracts that have the potential to impart knowledge to attendees, which enables them to make cost effective program improvements in their workplaces as a result of what they learn by attending the event, and thereby helping to pay for the investment made for their attendance to the NEHA AEC.

Virtual AEC

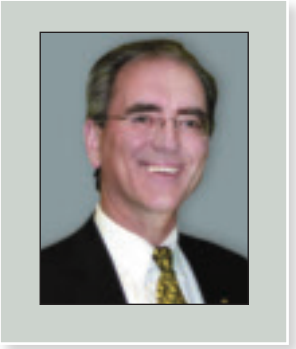
NEHA continues to offer attendees the opportunity to access the AEC online with a number of educational sessions being streamed as they happen live at the AEC. Thus, abstract submitters should be aware that if accepted, their abstracts and presentations may also be part of the Virtual AEC. Certain presentations on particularly pertinent issues will be selected for live webcasting during the event, and presenters are required to engage with attendees on the Virtual AEC as well.

Submission Process

Individuals and groups involved in all aspects of environmental health and public health are strongly encouraged to participate in this Call for Abstracts. If you have a presentation, please submit your abstract electronically at neha2014aec.org.

Submit your abstract today!

MANAGING EDITOR'S DESK



Nelson Fabian, MS

How NEHA Helps You to Keep Your Job and Be Employed

Anyone who knows me well knows that I don't claim absolute knowledge for very many issues. When the issue of how fast this world is moving comes up, however, I am quick to speak up and assert with no qualifiers that life moves faster today than ever and that this speed is—if anything—increasing.

As one NEHA member, Ron de Burger, recently put it to me, "it used to be that people wouldn't start to complain about our response until 10 days had passed; now it's 10 minutes!"

And so it goes … with just about everything.

With the speed at which this world is moving as my backdrop, let me now proceed to dig into the issue of "jobs" and more specifically, what people like you can do to protect your jobs.

Over the past year, I've devoted a significant amount of my reading time to the topic of jobs (and especially job creation). I've sought to become more knowledgeable about this topic in order that I might better understand the forces that are shrinking the public/environmental health profession and what can be done about them.

In addition to finding my way to a better understanding of the macro forces that are pounding both our profession and most other public-sector professions, I have also been peering more deeply into the everyday world of work, which has helped me to better appreciate issues as disparate as the multigenerational workplace and entirely new models of work life.

On this issue of new models, I've been particularly fascinated by how the 30-year career has become increasingly rare. It is being replaced with a model that features an unending cycle of job stints that typically involve high levels of stress on the front and back ends. In addition, a growing strand of the literature observes that Gen X and Y more and more see themselves as single-person-focused "self-corporations" that essentially contract out their services for specific projects and/or specific periods of time. The message to employers is that we can expect to spend a lot of our time in the future negotiating contracts with these single-person corporations as opposed to cultivating work environments that are populated by career employees.

> *To keep pace with how the world of work is changing, lifelong learning is no longer a nice-sounding pastime to give lip service to.*

Irrespective of any of the particulars that explain what is happening to the world of work, a strong message is behind all of this for anyone interested in staying gainfully employed to say nothing of having a job that brings self-fulfillment and happiness. To keep pace with how the world of work is changing, lifelong learning is no longer a nice-sounding pastime to give lip service to; it is essential for anyone who seeks to have a gainful, fulfilling, and sustainable work experience.

Given how fast this world is changing, there is no alternative to lifelong learning for keeping job skills and expertise current. The guaranteed job is fast becoming a relic from the past. With the financial pressures that exist on virtually all employers—public and private—there is no room any longer for that person who isn't keeping their skills and knowledge base up-to-date daily. To put it bluntly, such employees are no longer of value to the employer. In the vocabulary of the day, such employees offer little "ROI" for the employing business or agency.

In order to keep up, remain relevant, and preserve one's employability, it is more important than ever to live the life of a lifelong learner. Anyone who is standing still with his/her knowledge base quickly falls behind. There are just too many others who are devoting time to keeping up with this fast-paced and quickly changing world.

In some of the job books I've read, there is swift mention of the value of a college education and the half-life of knowledge. These passages have caused me to laugh when I think of my own college education and how useful the knowledge I gained from it is to me today. Little of what I learned is relevant any longer (except some of the science basics and shorthand) and some of that knowledge (especially in management) has proven over time to be just plain wrong!

Taking this a step further, it is now asserted that half of what is known today was not known 10 years ago. According to the American Society of Training & Development, the amount of knowledge in the world is now doubling every 18 months! (Pause for a second to

continued on page 74

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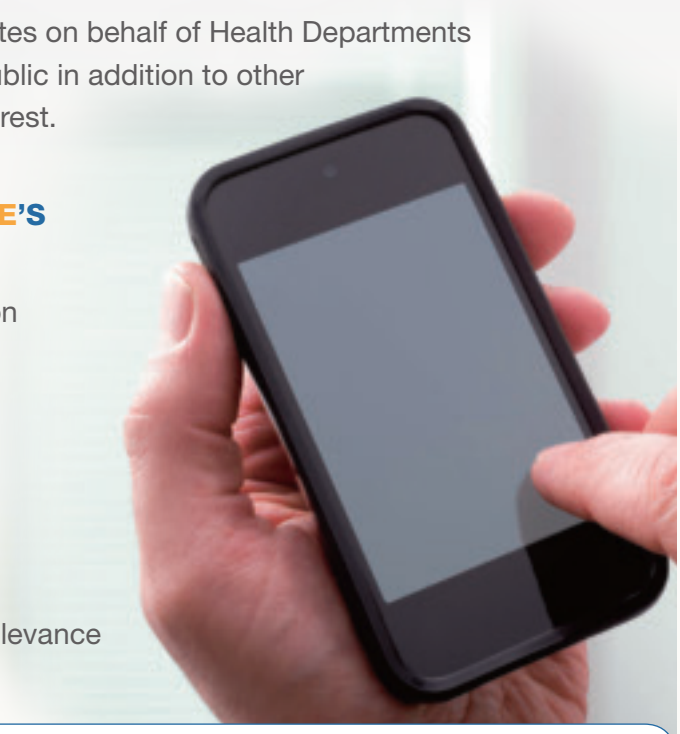

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