COUNTY CORRECTIONS

C. PERFRINGENS

Investigating an Outbreak at a Correctional Facility
Is this your current method of data collection?

For easier and more efficient inspections
Call SWEEPS Today!

“Make Your Data Work As Hard As You Do!”

For More Information:
(800) 327-9337
info@SweepsSoftware.com

Software for Environmental and Consumer Health Agencies
Approximately 11% of foodborne outbreaks caused by Clostridium perfringens occur in correctional facilities. This month's cover article investigates an outbreak caused by C. perfringens infection and intoxication at a county correctional facility. Based on estimates and projection calculations, the outbreak sickened 250–666 inmates. While four different food items—chicken taco meat mixture, cheese sauce, rice, and beans—tested positive for C. perfringens enterotoxin, outbreak investigation findings point to the chicken taco meat mixture as the culprit. See page 8.

Cover photos © iStock.com/Bonilla1879 and pamela_d_mcadams

ADVANCEMENT OF THE SCIENCE
Outbreak Caused by Clostridium perfringens Infection and Intoxication at a County Correctional Facility ................................................................. 8
Gastroenteritis Associated With Rafting the Middle Fork of the Salmon River—Idaho, 2013 ............................................................................................................ 14
Incidence of Non-Hodgkin Lymphoma and Residential Proximity to Superfund Sites in Kentucky ........................................................................... 22

ADVANCEMENT OF THE PRACTICE
Special Report: Benefits of a Study Abroad Element in the Environmental Health Curriculum ......................................................... 30
Direct From AAS: Cross-Training: It’s Not Just for Athletes! .......................................................................................................................... 34
Direct From CDC/EHSB: Understanding the Needs, Challenges, Opportunities, Vision, and Emerging Roles in Environmental Health .................................................. 36

ADVANCEMENT OF THE PRACTITIONER
EH Calendar .............................................................................................................................. 38
Career Opportunities ................................................................................................................ 39
Resource Corner ..................................................................................................................... 40
JEH Quiz #1 ............................................................................................................................. 41
JEH Corresponding Author and Subject Index: Volume 79 ................................................ 42

YOUR ASSOCIATION
President's Message: All Generations Need Apply .................................................................. 6
NEHA 2018 AEC ....................................................................................................................... 46
NEHA Organizational Members .......................................................................................... 47
Special Listing .......................................................................................................................... 48
Tribute to 2016–2017 JEH Peer Reviewers ......................................................................... 50
NEHA News ............................................................................................................................. 52
DirecTalk: Musings From the 10th Floor: Professional (dis) Association ................................ 54

E-JOURNAL BONUS ARTICLE
International Perspectives: Characteristics of Airborne Asbestos Concentrations in Korean Preschools ................................................................................. E1
Showcase Environmental Health and All It Encompasses

For many years NEHA’s Journal of Environmental Health has been adorned by visually stunning and creative covers portraying a wide variety of environmental health topics. You can now own these amazing cover images in poster size. Use the walls of your department and office to display to visitors, your boss and staff, and the public what environmental health encompasses and your pride in your profession.

For more information and to place your order:
⇒ Go to neha.org/publications/journal-environmental-health
⇒ Contact us at jeh@neha.org

3
2
1

24x36”
18x24”
8.5x11”

• Three different sizes
• Laminated, high-quality prints
• Select covers from 2005 to the present
Updated and Redesigned to Meet the Needs of Today’s Learner

NEHA
PROFESSIONAL FOOD MANAGER
5th Edition

INSIDE THIS EDITION

- Instructional design focused on improved learning and retention
- Content aligns with American Culinary Federation Education Foundation competencies
- Prepares candidates for CFP-approved food manager exams (e.g., Prometric, National Registry, ServSafe, etc.)
- All-new instructor guide and companion classroom materials
- Volume discounts for NEHA Food Safety Instructors

To order books or find out more about becoming a NEHA Food Safety Instructor, call (303) 802-2166 or visit neha.org
I am very honored to serve you as NEHA’s president during this coming year. I think you will find that I am going to be a very different sort of president than my predecessors. To be clear, we have been blessed with a series of incredible presidents over the past handful of years. I have had the privilege of serving with these tremendous men and women on the NEHA board of directors since 2010. They have taught me a great deal and I pray that I can carry their legacy forward. Their work, and sometimes it was painfully difficult work, has led our association to a place of unprecedented strength and influence. I am grateful for their leadership and I hope I can match their enthusiastic embrace of our beloved association, but I want you to know that I am going to be a very different sort of president.

Many of my predecessors were either retired or in the third act of their professional careers. These situations were a blessing to our association in many ways because they were empowered to give generous amounts of time to NEHA’s business. They were also able to personally travel to an astounding number of meetings and events. Their service and travel was important for the growth of the association during those periods of time. I believe, however, that the leadership of our association should not be limited exclusively to individuals from one generation or at one stage of professional life. I will do my very best to follow in their footsteps and to represent the association in as many places as possible. To this end, I will use technology and other tools to demonstrate that people with careers and young families can be involved with NEHA’s leadership.

I believe in the value of diversity—the variety of generations that is currently working in our profession provides us with great strength. Generational perspectives inform how we see the world and the values that we hold dear. Our association needs to reflect this truth and engage all generations in the work of leading us forward. NEHA will not reach its potential without all of you, regardless of generation, being actively engaged in the collective work of professional development and advancing our causes.

I was born in the 1970s and grew up in the 1980s and 1990s, making me the first NEHA president to represent Generation X. The first movie I can remember seeing at the theater was E.T. the Extra-Terrestrial. Arcade video games consumed far too many of the quarters that I earned delivering newspapers on my bicycle. I watched families like the Cunninghams, Waltons, Cosbys, and Keatons. None of them looked much like my family with divorced parents, stepparents, and half-siblings. I listened to hair metal bands followed by grunge music during my college years at Ferris State University in my beloved hometown of Big Rapids, Michigan. I saw Halley’s Comet and wondered if I would live long enough to see it again. As a matter of fact, I still wonder about that! I will never forget watching the space shuttle Challenger disaster on television in Mr. Seaver’s fifth grade classroom. My environmental health sensitivities were formed as a child, in part, by ozone holes, the Exxon Valdez, and the Chernobyl nuclear reactor meltdown. If some of these things resonate with you, I am calling on you to get more involved—it’s time!

In addition to having a full-time job as the health officer of a local health department in Michigan, I am also married with six wonderful children. Our children range in age from seven to 20 years. I suspect that you will be hearing about at least a few of them in the stories that I will tell in upcoming columns or during conferences. I believe that it is important for busy people with families and full-time employment to be willing and able to lead NEHA. An association that can only be led by one certain type of person is probably an unhealthy association.

A few years ago, when I decided to run for NEHA president, I told the attendees of our Annual Educational Conference (AEC) & Exhibition a true story about two young boys I encountered while collecting water samples
at a Lake Michigan beach. Those little boys exclaimed, “Mom, he’s like a superhero who protects us from germs!” As silly as that might sound, those boys understood something that we often struggle to communicate—our true cause and calling. I believe that you truly are superheroes called to protect your communities from preventable illnesses and injuries. Environmental health is a noble profession and you truly are heroic. As we all know, however, all superheroes have weaknesses and they all need allies and supporters. My promise to you is that this association will strive to provide you with the tools and support you need to grow as a professional and to serve your community. As a NEHA member, you belong to a club of extraordinary people and more important, you belong to a cause that is changing the world for the better.

Lastly, I hope to see you in Grand Rapids for NEHA’s 81st AEC taking place July 10–13. You may have heard that this city has made lots of top 10 lists for best places to visit. I have lived in Grand Rapids for the past 16 years and based upon my personal experience, you will have a great time in Grand Rapids! The conference site is in one of the most walkable downtowns in the U.S. There are scores of museums, microbreweries, music venues, theaters, restaurants, and more within an easy walk from the host hotel. I look forward to seeing you in Grand Rapids and working with you during my presidency.

DELEGATE CLUB ($25–$99)
Name in the Journal for one year and endowment pin.
Freda W. Bredy
Alexandria, VA

HONORARY MEMBERS CLUB
($100–$499)
Letter from the NEHA president, name in the Journal for one year, and endowment pin.
Tim Hatch, MPA, REHS
Montgomery, AL
Lynne Madison, RS
Hancock, MI
Paschal Nwako, MPH, PhD, REHS, CHES, DAAS
Blackwood, NJ
Larry Ramdin, REHS, CP-FS, HHS
Salem, MA
Ned Therien, MPH
Olympia, WA

21st CENTURY CLUB
($500–$999)
Name submitted in drawing for a free one-year NEHA membership, name in the Journal for one year, and endowment pin.
Peter M. Schmitt
Shakopee, MN
LCDR James Speckhart, MS
Silver Spring, MD
Leon Vinci, DHA, RS
Roanoke, VA

SUSTAINING MEMBERS CLUB
($1,000–$2,499)
Name submitted in drawing for a free two-year NEHA membership, name in the Journal for one year, and endowment pin.
James J. Balsamo, Jr., MS, MPH, MHA, RS, CP-FS
Metairie, LA
Gavin F. Burdge
Lemoyne, PA
Bob Custard, REHS, CP-FS
Lovettsville, VA

Kent R. Christensen
Spokane, WA

AFFILIATES CLUB
($2,500–$4,999)
Name submitted in drawing for a free AEC registration, name in the Journal for one year, and endowment pin.
Vince Radke, MPH, REHS, CP-FS, DAAS, CPH
Atlanta, GA

EXECUTIVE CLUB AND ABOVE
($5,000–$100,000)
Special invitation to the AEC President’s Reception, name in the Journal for one year, and endowment pin.

Thank you.
Outbreak Caused by *Clostridium perfringens* Infection and Intoxication at a County Correctional Facility

Adam E. London, MPA, RS, DAAS
Julie A. Payne, MPH
Brian Hartl, MPH
Kent County Health Department

Abstract

Outbreaks of foodborne illness caused by *Clostridium perfringens* are not usually the result of intoxication and testing of suspected menu items for colony count can often identify the causative item. We describe a large outbreak at a county correctional facility in which the data suggest that illness by intoxication contributed substantially to the outbreak: 29 out of 108 surveyed cases (26.9%) developed symptoms within 2.5 hr of when meal service began. Inmate testimony further suggests advanced food decay. Bacterial analyses of food samples indicated a smaller population of *C. perfringens* in the chicken taco meat mixture (<10 CFU/g, enterotoxin positive) compared with other items. Statistical analyses of food history data provided substantially more support for the chicken taco meat mixture as causative (odds ratio = 55.79, 95% confidence interval [19.72, 157.83], *p* < .001) than other menu items. Environmental investigation and testimony from inmates provided additional support implicating the chicken taco meat mixture.

Introduction

On April 16, 2012, at 8:30 a.m., the Communicable Disease/Epidemiology Unit of the Kent County Health Department (KCHD) in Grand Rapids, Michigan, received a telephone call from an employee of the Kent County Correctional Facility (KCCF). The KCCF employee reported that a foodborne illness outbreak was suspected to be taking place at the facility. The caller stated that approximately 30–50 inmates had become ill with vomiting and diarrhea after eating lunch at the facility on April 15, 2012. The estimate of inmates who were ill later increased to 250 out of 1,140 inmates as more information became available. No employees of the correctional facility were known to be ill at that time. The caller indicated that the lunch meal from the prior day was suspected to be the cause because many of the inmates complained about a foul taste and odor associated with it. That meal was served to inmates between 10:30 a.m. and 12:30 p.m. on April 15 and consisted of a chicken taco meat mixture, rice with cheese sauce, refried beans, and a flour tortilla. A garden salad with optional salad dressing, yellow cake, and powdered fruit drink were also offered. According to the caller, many people become ill within 1 hr after consuming the meal. Other inmates, however, developed symptoms throughout the remainder of that day and into the morning of April 16. Upon receipt of this information, KCHD organized to investigate the suspected outbreak.

Methods

Following the report of illnesses on April 16, 2012, KCHD created investigation objectives to investigate the suspected outbreak by gathering appropriate epidemiological and environmental data. The team gathering epidemiological data consisted of epidemiologists, public health nurses, and sanitarians. They developed a questionnaire using the KCCF menu for the 72 hr prior to the first report of illnesses.

Personal interviews were requested with inmates due to reported low literacy rates within that population. KCHD staff conducted those interviews at the correctional facility on April 17–19. A total of 185 inmates, including ill and well individuals, were interviewed. Questions included: sex, age, food consumed, symptoms experienced, date and onset of those symptoms, duration of illness, and whether medical care was obtained. The case definition was described as any interviewee reporting vomiting and/or diarrhea. Data analyses were performed using the Epi Info 6 Database Analysis Program from the Centers for Disease Control and Prevention (CDC). This team also identified ill inmates who were willing to provide stool samples for laboratory analyses. Those samples were collected and submitted to the Michigan Department of Community Health laboratory for both bacterial analyses and enterotoxin identification through polymerase chain reaction (PCR).

A second work team was charged with gathering environmental data from the...
KCCF. This team, consisting primarily of sanitarians, assessed the food preparation and service areas, investigated the history of the suspect meals, questioned employees for relevant information, and gathered food samples as appropriate. Correctional facilities are not licensed public food service operations in the State of Michigan; however, the KCHD sanitarians used the Michigan Food Law of 2000 (Public Act 92 of 2000), the 2005 Food and Drug Administration (FDA) Food Code, and generally accepted best food safety practices as guidance for conducting this investigative inspection. Food specimens were analyzed using PCR for enterotoxin source identification and incubated for plate count.

It should be noted that the Kent County Sheriff’s Department also investigated the circumstances associated with the outbreak to determine if an act of intentional food adulteration had occurred. The sheriff’s department and KCHD worked collaboratively to share valuable information essential to each department’s respective investigation.

**Results**

**Epidemiological**

Of the 185 surveyed individuals who consumed lunch on April 15, 2012, 108 of them were identified as ill according to the case definition. The survey results demonstrated an overall attack rate of 58.4%. It is, however, important to acknowledge that it was not possible to interview all inmates and that sickened inmates may have been biased toward participating in the survey than their unaffected counterparts. The actual number of sick inmates likely ranged between 250 (KCCF estimate) and 666 (projection calculated by survey attack rate). The profile of the outbreak was representative of the overall KCCF population (Table 1).

Onset of symptoms ranged from April 15 at 11:00 a.m. to April 18 at 8:00 p.m. The period of duration between exposure to the suspect meal and onset of illness ranged from <1 hr to 81 hr, with a mean onset of 9 hr and a median onset of 7 hr. The greatest frequency of illnesses occurred within 1 hr after eating the lunch meal on April 15. As illustrated by the epidemic curve (Figure 1), 29 of the 108 ill interviewees (26.9%) reported an onset of illness within 2.5 hr of when the lunch service began. No employees of KCCF or of the contracted food service company reported illness and none reported consuming the lunch meal on April 15.

Data analyses (Epi Info 6) were utilized to evaluate the 60 food items consumed by the KCCF population during the previous 72 hr according to the menu. Odd ratios (OR) and 95% confidence intervals (CI) were calculated and \( p < .05 \) was used as a standard for significance. Interviewees were asked to indicate if they had consumed each of these 60 items. ORs for illness related to each of the food items consumed before April 15 were insignificant. Food items consumed on April 15 demonstrated statistically significant ORs indicating powerful likelihood of relationship (Table 2). The chicken taco meat mixture demonstrated a substantially greater OR than all other menu items: \( OR = 55.79, 95\% CI \ (19.72, 157.83), \ p < .001 \).

During the course of the interviews, KCHD identified a subgroup of work release employees with a unique experience. This subgroup was presented with the same lunch on April 15 as other inmates, but they had heard from other inmates that there was something wrong with the chicken taco meat mixture. The offensive odor of this food item was a common comment from the interviewees. Of the 42 work release employees, only 3 reported eating the chicken taco meat mixture and only 8 (19%) became ill. It should be noted that the chicken taco meat mixture was often physically in contact with other food items on the serving tray. This contact might have transmitted infectious material and/or enterotoxins from one food item to another in the pre-prepared serving tray.

Stool specimens were collected from four ill inmate volunteers on April 16 and from two additional inmate volunteers on April

| TABLE 1 |

<table>
<thead>
<tr>
<th>Profile of Surveyed Ill Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristics</strong></td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Age (year)</td>
</tr>
<tr>
<td>10–19</td>
</tr>
<tr>
<td>20–49</td>
</tr>
<tr>
<td>50–74</td>
</tr>
<tr>
<td>Missing information</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td><strong>Symptoms</strong></td>
</tr>
<tr>
<td>Nausea</td>
</tr>
<tr>
<td>Vomiting</td>
</tr>
<tr>
<td>Abdominal cramps</td>
</tr>
<tr>
<td>Diarrhea</td>
</tr>
<tr>
<td>Bloody diarrhea</td>
</tr>
<tr>
<td>Fever</td>
</tr>
</tbody>
</table>

*Onset: range = <1–81 hr, mean = 9.3 hr, and median = 7 hr. Duration: range = 1–60 hr, mean = 19.13 hr, median = 17 hr.*
Meal served on April 14, 2012, demonstrates contact of items in large serving section. Photo courtesy of Kent County Health Department.

17. Based upon a recommendation by the Michigan Department of Community Health, specimens were sent to their laboratory and analyzed for *Bacillus cereus* and *C. perfringens*. All six specimens were found to be negative for *B. cereus* and positive for *C. perfringens*. Confirmatory PCR analyses detected the presence of *C. perfringens* enterotoxin in all six specimens.

**Environmental Health**

The KCHD environmental health investigation team conducted an initial investigation at the KCCF facility on April 16, 2012, and made several follow-up visits during the subsequent two weeks. The team learned that food service operations at KCCF were contracted to a private company responsible for preparing meals, supervising kitchen trustees (inmates who are assigned to work in the kitchen under supervision), and ensuring food safety. Management staff from that company informed the KCHD environmental health team that the chicken taco meat mixture was heated on Monday, April 15 when the food was removed from the cooler and prepared for lunch service by reportedly reheating it to 200 °F (93.3 °C) in steam kettles and then placing it in a hot holding unit. A kitchen trustee stated that the workers in the kitchen noticed that the hot holding unit did not appear to be working properly, so they transferred the chicken taco meat mixture to a pizza oven set at 150 °F (65.6 °C) for hot holding. The kitchen trustee also reported that the chicken taco meat mixture had “swelled and overflowed” and a strong odor was observed when the pans were being transferred to the pizza oven. The contracted kitchen manager later reported that she checked the temperature of the pizza oven and discovered that it was holding at 90 °F (32.2 °C). A number of others reported that the chicken taco meat mixture had a very offensive odor and was “bubbly” and “frothy.” The food processing and handling histories for the other meal items were investigated and were found to comply with recipe directions and without apparent abuse.

While this trustee’s claim could not be confirmed, KCCF employees stated that it is not unusual to combine leftovers into new meals in order to conserve resources. The sources agree that the chicken taco meat mixture was brought to a simmer and then placed in large steel pans 4–6 in. deep, temporarily placed on a rack in the freezer for an undisclosed period of time, and then covered in plastic wrap and placed in the walk-in cooler. There was no indication that the temperature of that chicken taco meat mixture was recorded at that time or subsequently monitored until Sunday, April 15 when the food was removed from the cooler and prepared for lunch service by reheating it to 200 °F (93.3 °C) in steam kettles and then placing it in a hot holding unit. A kitchen trustee stated that the workers in the kitchen noticed that the hot holding unit did not appear to be working properly, so they transferred the chicken taco meat mixture to a pizza oven set at 150 °F (65.6 °C) for hot holding. The kitchen trustee also reported that the chicken taco meat mixture had “swelled and overflowed” and a strong odor was observed when the pans were being transferred to the pizza oven. The contracted kitchen manager later reported that she checked the temperature of the pizza oven and discovered that it was holding at 90 °F (32.2 °C). A number of others reported that the chicken taco meat mixture had a very offensive odor and was “bubbly” and “frothy.” The food processing and handling histories for the other meal items were investigated and were found to comply with recipe directions and without apparent abuse.

The contracted food service provider was able to provide KCHD investigators with sample meals from the dates in question. As a contractual requirement, they preserved these meals, popularly known as “dead man’s trays,” in the cooler for several days in order to support foodborne illness investigations. While no photographs of the suspected meal from April 15 were taken, KCHD investigators did photograph a meal from the prior day that demonstrates the general presentation and appearance of meals served at KCCF. It should also be noted that the meal items in the large section of the tray (beans and rice) contacted one another in a similar way as was reported from the April 15 meal (chicken taco meat mixture, rice with cheese, and beans). This sort of contact between meal items in the tray enables migration of microorganisms from one item to another.

Specimens of the chicken taco meat mixture, beans, rice, cheese sauce, and tortillas were sent to Michigan Department of Community Health Bureau of Laboratories for analyses. Cultured plate counts for *C. perfringens* found the rice and cheese mixture to contain 1.5 x 10⁷ CFU/g, the beans contained 3.7 x 10⁴ CFU/g, and the chicken taco meat mixture contained <10 CFU/g. Confirmatory analyses using PCR determined that the chicken taco meat mixture, rice with cheese sauce, and beans all contained *C. perfringens* enterotoxin.

**FIGURE 1**

Epidemic Curve

<table>
<thead>
<tr>
<th>Date/Time of Illness Onset</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>22</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 15, 2012</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>April 16, 2012</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>24</td>
<td>26</td>
</tr>
</tbody>
</table>
The environmental health investigation also identified a number of conditions non-compliant with the 2005 FDA Food Code and best food safety practices. Monitoring and maintaining proper temperature controls in an institution are essential for reducing the risk of enteric outbreaks (Greig, Lee, & Harris, 2011). In addition to significant time and temperature control deficiencies, non-compliant conditions included, but were not limited to faulty equipment, failure to date mark food, inadequate sanitizing process for dishware, poor utensil storage, inadequate hand washing sinks, evidence of pests, and a number of minor maintenance issues. A report consisting of 23 food safety improvement recommendations was issued to KCCF and the contracted food service company as a result of these findings.

**Criminal**

Investigators from the Kent County Sheriff’s Department interviewed 20 inmates who had been assigned as trustees to work in the kitchen under general supervision from the contracted food manager. The purpose of the Kent County Sheriff’s Department investigation was to determine if the food had been criminally adulterated. Their interviews with trustees did reveal information pertinent to the KCHD investigation (presented in the previous sections of this article), but did not find compelling evidence of criminal action.

**Discussion**

According to the FDA (2012) and the CDC (2017a), *C. perfringens* is a spore-forming facultative bacterium located throughout the environment but found primarily in the intestines of humans and many animals. The bacteria are commonly found in raw meat products. Small numbers of the organism often are present after cooking and subsequently multiply to dangerous levels during improper cooling and storage of prepared foods. Meats, meat products, and gravy are the foods most frequently associated with outbreaks caused by *C. perfringens*. Illness generally is caused when sufficient numbers of the microbe are consumed and subsequently produce toxin in the intestines. The infection usually requires 8–12 hr to incubate before causing diarrhea and abdominal cramping, which subsides in approximately 24 hr. Correctional facilities and similar environments previously have been associated with these outbreaks (CDC, 2009; CDC, 2012).

Approximately 11% of foodborne outbreaks caused by *C. perfringens* occur in correctional facilities and 92% are related to meat and poultry (Grass, Gould, & Mahon, 2013). Cases of intoxication are rare, in part because the food becomes very offensive to the senses when this level of decay has occurred. Intoxication is typified by a rapid onset of colic and diarrhea (Heymann, 2015). The presence of vomiting (38.6% of cases) in this outbreak is also suggestive of something unusual, such as intoxication, considering that *C. perfringens* usually only correlates with vomiting in 9% of cases (Bennett, Walsh, & Gould, 2013).

Food and stool specimens confirmed that the outbreak of gastroenteritis at KCCF was caused by *C. perfringens* infection and/or intoxication. The epidemiological investigation in this case demonstrated that the chicken taco meat mixture was the most statistically probable exposure causing the

<table>
<thead>
<tr>
<th><strong>TABLE 2</strong></th>
<th>Attack Rates for Foods of Significance Consumed on April 15, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ill</strong></td>
<td><strong>Ate</strong></td>
</tr>
<tr>
<td><strong>Did not eat</strong></td>
<td>33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>101</td>
</tr>
<tr>
<td><strong>Illness rate (%)</strong></td>
<td>67</td>
</tr>
<tr>
<td><strong>Well</strong></td>
<td><strong>Ate</strong></td>
</tr>
<tr>
<td><strong>Did not eat</strong></td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>72</td>
</tr>
<tr>
<td><strong>Wellness rate (%)</strong></td>
<td>44</td>
</tr>
<tr>
<td><strong>Respondents</strong></td>
<td>145</td>
</tr>
<tr>
<td><strong>OR</strong></td>
<td>2.58</td>
</tr>
<tr>
<td><strong>95% CI</strong></td>
<td>1.4, 4.8</td>
</tr>
<tr>
<td><strong>p-value</strong></td>
<td>.002</td>
</tr>
</tbody>
</table>

OR = odds ratio; CI = confidence interval.
illnesses and the environmental investigation found significant abuse of this item. The laboratory analyses, however, suggested that the rice with cheese and/or the beans were the causative exposure (Table 3). CDC (2017b) provides a confirmation guideline of $1 \times 10^5$ \textit{C. perfringens} organisms/g in suspect food items, which supports the case for rice with cheese and/or the beans. Due to the apparent conflict between the laboratory and statistical results, further consideration of the data was required. Two possibilities emerged for the number of \textit{C. perfringens} numbers in the meat, rice, with cheese, and beans.

One hypothesis suggested that—through either sampling error, laboratory error, or uneven distribution of organisms—the chicken taco meat mixture sample that was analyzed for colony count was uniquely underrepresented with viable \textit{C. perfringens} organisms. The second hypothesis held that an uneven distribution of organisms—the bacteria population within the chicken taco meat mixture was either reached death phase due to gross spoilage, diminishing nutrients, and a changing pH environment, or had been diminished by the final reheating prior to service on April 15 without harming the integrity of the enterotoxin.

Vegetative spores of \textit{C. perfringens} are inactivated by cooking temperatures of 131 °F (55 °C) for 16.3 min to 149 °F (65 °C) for 0.9 min (Byrne, Dunne, & Bolton, 2006). \textit{C. perfringens} enterotoxin is inactivated at 140 °F (60 °C) for five min (International Commission on Microbiological Specifications for Foods, 2003). The unreliable reheating in the faulty equipment on April 15 possibly could have inactivated vegetative spores, but not the enterotoxin, and left the remaining spores with greatly decayed growth media in the chicken taco meat mixture. As a result, the chicken taco meat mixture environment contained \textit{C. perfringens} enterotoxin but contained a nearly undetectable number of viable organisms. Under this second hypothesis, the high concentrations of \textit{C. perfringens} organisms in the cheese/rice mixture and refried beans was caused by contamination from the chicken taco meat mixture when the items contacted one another in the serving tray.

The organisms would have found an acceptable growth media in these newly exposed items and could have multiplied substantially by the time samples of those items were submitted to the laboratory. Meanwhile, the suitability of the chicken taco meat mixture was waning and the population of viable organisms could have decreased to <10 CFU/g when the laboratory received the sample. The observations from inmates and staff regarding a strong foul smell and gas bubbles within the chicken taco meat mixture appear to support this second hypothesis.

**Conclusion**

This outbreak of foodborne illness caused by \textit{C. perfringens} exhibited the characteristics of an uncommon intoxication due to the short onset of illness experienced by many of the inmates who ate the food and the testimony of foul odor and “bubbly” chicken taco meat mixture. The occurrence of nausea (67.3%) and vomiting (38.6%) may also suggest toxin ingestion. Outbreaks caused by \textit{C. perfringens} intoxication may be uncommon, but it is important to recognize that individuals with limited control of their diet options may be more vulnerable. The illnesses of other inmates were more likely caused by infection in the more frequently observed manner. While the data appear to suggest conflicting causative food items, KCHD concluded that the chicken taco meat mixture was the most

---

**TABLE 3**

**Evidence Summary for Foods of Significance**

<table>
<thead>
<tr>
<th>Food Type</th>
<th>Attack Rate (%)</th>
<th>OR (95% CI)</th>
<th>p-Value</th>
<th>\textit{Clostridium perfringens} (CFU/g)</th>
<th>\textit{Clostridium perfringens} enterotoxin</th>
<th>Environmental Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot cereal</td>
<td>67</td>
<td>2.58 (1.4, 4.8)</td>
<td>.002</td>
<td></td>
<td></td>
<td>Evidence of time/temperature abuse. Offensive odor and “frothy” appearance reported. Served in contact with cheese, rice, and refried beans.</td>
</tr>
<tr>
<td>Breakfast sausage</td>
<td>80</td>
<td>6.79 (3.4, 13.6)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bakery biscuit</td>
<td>74</td>
<td>4.04 (2.1, 7.7)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>74</td>
<td>3.76 (1.9, 7.2)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken taco meat mixture</td>
<td>95</td>
<td>55.79 (19.7, 157.8)</td>
<td>&lt;.001</td>
<td>&lt;10</td>
<td>Positive</td>
<td>Evidence of time/temperature abuse. Offensive odor and “frothy” appearance reported. Served in contact with chicken taco meat mixture, rice, and refried beans.</td>
</tr>
<tr>
<td>Cheese sauce</td>
<td>94</td>
<td>8.85 (3.4, 23.0)</td>
<td>&lt;.001</td>
<td>1.5 x 10**</td>
<td>Positive*</td>
<td>Served in contact with chicken taco meat mixture, rice, and refried beans.</td>
</tr>
<tr>
<td>Flour tortilla</td>
<td>95</td>
<td>7.38 (2.6, 20.9)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td>Generally consumed with chicken taco meat mixture and other items. Unlikely \textit{C. perfringens} media.</td>
</tr>
<tr>
<td>Rice</td>
<td>94</td>
<td>5.82 (2.32, 14.6)</td>
<td>&lt;.001</td>
<td>1.5 x 10**</td>
<td>Positive*</td>
<td>Served in contact with chicken taco meat mixture, cheese sauce, and refried beans.</td>
</tr>
<tr>
<td>Refried beans</td>
<td>83</td>
<td>3.77 (1.9, 7.4)</td>
<td>&lt;.001</td>
<td>3.7 x 10**</td>
<td>Positive</td>
<td>Served in contact with chicken taco meat mixture, cheese sauce, and rice.</td>
</tr>
</tbody>
</table>

\textit{OR = odds ratio; CI = confidence interval.}

*Cheese sauce and rice were tested together due to extensive mixing in serving tray.*
probable cause. The high odds ratio, history of temperature abuse, possible contamination by external ingredients, and testimony from inmates regarding strong odor and frothy appearance seem consistent with *Clostridium perfringens* in the taco meat mixture.

The findings from this outbreak response demonstrate that investigators of similar foodborne illness outbreaks should recognize the possible insufficiency of bacterial colony counts from food samples for identifying the causative menu item of a foodborne illness outbreak. A full review of the environment, food history, statistical analyses, and population dynamics should be considered before developing conclusions.

---

**References**


Byrne, B., Dunne, G., & Bolton, D.J. (2006). Thermal inactivation of *Bacillus cereus* and *Clostridium perfringens* vegetative cells and spores in pork luncheon roll. *Food Microbiology*, 23(8), 803–808.


---

**Corresponding Author:** Adam London, Health Officer, Kent County Health Department, 700 Fuller NE, Grand Rapids, MI 49503.

E-mail: adam.london@kentcountymi.gov.
Gastroenteritis Associated With Rafting the Middle Fork of the Salmon River—Idaho, 2013

Abstract  During July–August 2013, a gastroenteritis outbreak occurred among rafters at Idaho’s Middle Fork of the Salmon River. To identify the agent, source, and risk factors for illness, we solicited ill and well persons who rafted during July 1–September 23 to respond to an online survey, and conducted a case-control study. Cases were defined as nausea, vomiting, or diarrhea ≤25 days after rafting; control subjects were rafters who did not have these symptoms. Illness was associated with having consumed filtered river water—70% (69/98) of case subjects and 38% (106/280) of control subjects had consumed filtered water (odds ratio [OR] = 3.9; 95% confidence interval [CI] [2.4, 6.4]). In a follow-up online survey of 33 case subjects and 73 control subjects, boiling water for drinking was protective against illness; 2/18 case subjects, compared with 15/33 control subjects, had boiled their drinking water (OR = 0.2; 95% CI [0.03, 0.9]). From ill rafters, norovirus (n = 3) and Giardia (n = 8) were detected in stool specimens. Norovirus was detected on surfaces and E. coli in surface water used for drinking. Adherence to backcountry drinking water treatment recommendations is advised.

Introduction  Outbreaks associated with recreational water in the U.S. are detected and investigated by state, local, and federal health agencies and voluntarily reported to the Centers for Disease Control and Prevention (CDC). During 1971–2012, an estimated 48,528 cases of illness occurred in the U.S. as a result of outbreaks associated with recreational water (Craun, Calderon, & Craun, 2005; Dziuban et al., 2006; Hlavsa et al., 2011; Hlavsa et al., 2014; Hlavsa et al., 2015; Yoder et al., 2004; Yoder et al., 2008). Recreational water illnesses can be caused by bacteria, viruses, protozoa, and fungi, and can be transmitted by ingestion or contact with contaminated water in treated (e.g., swimming pools or drinking fountains) and untreated (e.g., lakes or rivers) venues. Approximately 91 million adults in the U.S. recreate in natural bodies of water annually (Centers for Disease Control and Prevention, 2016); during 2013, an estimated 3.8 million persons participated in rafting activities (Outdoor Foundation, 2014).

In the Frank Church River of No Return Wilderness in Central Idaho, the Middle Fork of the Salmon River traverses northeast at a mean discharge of 1,030 ft³ of water/second (measured in July–August 2013) through rugged mountains (Northwest River Forecast Center, n.d.). Each year, approximately 10,000 rafters embark on nonmotorized, whitewater rafting trips along this 104-mile stretch of river for an average of 4–10 days, in both private and commercial trips (U.S. Department of Agriculture, Forest Service [USFS], 2017). USFS requires all boating parties to have rafting permits and carry specific equipment, including a portable toilet (USFS, 2015). Private trips allow for dogs and group sizes of 1–24 rafters. Commercial trips have a maximum capacity of 30 persons, including professional guides. Meals, camping, and rafting gear; portable hand washing stations (commonly referred to by product name “Wishy Washy”); and toilet systems are provided by the outfitter. Twenty-seven Middle Fork outfitters are licensed, but only 3–4 outfitters may launch daily. Raft launch and takeout (exit) sites are at USFS campgrounds with flush and pit toilets, respectively. Approximately 90 primitive campsites, the majority accommodating groups of >20 persons, are located along the river, which is dotted with hot springs. Primitive camping, sometimes termed backcountry camping, involves few or no amenities such as piped water, picnic tables, or pit toilets. No road access exists aside from the launch and takeout sites; private airstrips can be used for emergency evacuation.

On July 24, 2013, emergency services personnel notified Eastern Idaho Public Health District (EIPHD) that five persons rafting for work-related purposes were transported from a river takeout site by ambulance to a local hospital because of nausea, vomiting, diarrhea, cramping, and dehydration. Upon contacting the hospital’s infection control practitioner, EIPHD learned that the five ill workers were treated for viral gastroenteritis, discharged, and no clinical specimens for laboratory testing were collected because patients were unable to produce stool. The ill workers were provided motel rooms and time away from work until they were symptom-free. Because norovirus was the sus-
expected cause of illness, a cleaning crew was hired to disinfect the motel rooms after they were vacated; the rafting equipment used on the work-related rafting trip was also disinfected. During July 24–August 6, 2013, until the Mudslide from heavy rains disrupted communication, EIPHD received qualitative reports from USFS regarding gastrointestinal illness among rafters. To determine the agent, source, and risk factors for gastrointestinal illness among rafters of the Middle Fork of the Salmon River during July 1–September 23, 2013, EIPHD began an investigation.

**Methods**

**Identification of Cases**

The cause of illness was unknown; therefore, we defined a case as nausea, vomiting, or diarrhea ≤25 days after rafting (maximum incubation period for giardiasis) in a person who had rafted July 1–September 23, 2013. To find persons who had rafted the Middle Fork of the Salmon River during July 1–September 23, 2013, EIPHD and the Idaho Department of Health and Welfare, Division of Public Health (DPH) solicited participants to respond to an online questionnaire through the media (e.g., 670 KBOI radio, local newspapers, and television), in person (i.e., at the Cache Bar river takeout on August 11, 2013), and by USFS sending e-mails to rafting permit holders to distribute to trip participants. To find additional ill patients, EIPHD requested that clinicians and hospital emergency departments contact EIPHD regarding patients who presented with gastroenteritis symptoms after rafting the Middle Fork. After receipt of laboratory results, we reclassified cases by gastrointestinal illness duration: norovirus-like gastroenteritis cases had an illness duration ≤3 days and Giardia-like gastroenteritis cases had an illness duration ≥4 days.

**Case-Control Study**

To identify risk factors for illness, EIPHD and DPH initiated a case-control study. Unmatched control subjects were well persons who had rafted July 1–September 23. We created an online questionnaire hosted by DPH August 7–October 22, and asked rafters to respond only if they rafted the river on or after July 1, 2013. Information from the questionnaire, which asked about symptoms, meals consumed, drinking water, and environmental exposures, helped us create definitions for cases and controls. To determine the total number of persons who went on rafting trips with a launch date during July 1–September 23, 2013, DPH requested information under the Freedom of Information Act (FOIA) from USFS regarding the number of permits issued. Information from USFS-issued rafting permits was used to determine whether group size or permit holder type was a risk factor for illness. Excel 2010, EpilInfo 7, and SAS version 9.1.3 were used for data analyses. Univariate analyses were performed to determine statistical significance of an association between illness and exposures (α = .05).

**Clinical Investigation**

During the investigation, EIPHD provided stool sample kits to USFS, clinics, and hospital emergency departments to be used for specimen submission to the Idaho Bureau of Laboratories (IBL) from patients who presented with symptoms of gastrointestinal illness after rafting the Middle Fork of the Salmon River during July 1–September 23, 2013. EIPHD also provided stool sample kits to USFS to collect stool samples from ill rafters who did not seek care. At IBL, stool samples were tested by culture for Salmonella, Shigella, Shiga-toxin producing E. coli, and Campylobacter; by direct fluorescent antibody (DFA) assay for Cryptosporidium and Giardia; and by reverse-transcription polymerase chain reaction (RT-PCR) assay for norovirus.

**Environmental Investigation**

To collect environmental samples at locations along the river, IBL provided supplies to
USFS, EIPHD, and the Central District Health Department (CDHD). Samples were collected during August–October 2013. Water samples for *E. coli* and coliform testing were collected and tested by using Standard Method 9223B (National Environment Methods Index, n.d.). To collect water, without additives, for norovirus and *Giardia* testing, 20 L collapsible containers were used. These were stored at 4°C until concentrated by ultrafiltration, at which point sodium polyphosphate (surfactant aid) was added (Hill et al., 2007). Sterile, dry swabs were used for collecting environmental samples from hard surfaces. Water samples from potable water spigots at Location A, from a tap and surface water source at Location C, and from springs at Locations E and F were collected and tested by DFA and RT-PCR for one or more of the following: *E. coli*, total coliform bacteria, *Giardia* cysts, *Cryptosporidium* oocysts, and norovirus.

**Follow-Up Study**

During March 5–April 5, 2014, to obtain additional information on drinking water treatment methods, sanitation, and disseminated educational materials, DPH administered a follow-up online questionnaire to study participants who had agreed to answer follow-up questions.

**Results**

**Participant Characteristics**

A total of 490 persons responded to the online questionnaire. The response to the FOIA request for information from the USFS showed that during July–August 2013, a total of 7,399 persons rafted the Middle Fork of

---

### TABLE 1

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Case Subjects</th>
<th></th>
<th>Control Subjects</th>
<th></th>
<th>Difference in % Exposed</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed</td>
<td>Unexposed</td>
<td>Exposed</td>
<td>Unexposed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td># (%)</td>
<td># (%)</td>
<td># (%)</td>
<td># (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ate at area restaurant pretrip</td>
<td>391</td>
<td>52 (51)</td>
<td>140 (48)</td>
<td>149 (52)</td>
<td>3</td>
<td>1.1</td>
<td>0.7, 1.7</td>
</tr>
<tr>
<td>Commercial (nonprivate) trip</td>
<td>395</td>
<td>24 (24)</td>
<td>64 (22)</td>
<td>229 (78)</td>
<td>1</td>
<td>1.1</td>
<td>0.6, 1.9</td>
</tr>
<tr>
<td>Prepared own meals during trip</td>
<td>391</td>
<td>77 (76)</td>
<td>230 (80)</td>
<td>59 (20)</td>
<td>5</td>
<td>0.8</td>
<td>0.5, 1.4</td>
</tr>
<tr>
<td>Outfitter prepared meals during trip</td>
<td>391</td>
<td>29 (28)</td>
<td>64 (22)</td>
<td>225 (78)</td>
<td>6</td>
<td>1.4</td>
<td>0.8, 2.3</td>
</tr>
<tr>
<td>Location A (mile 0, river launch site)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used/touched spigot</td>
<td>382</td>
<td>50 (52)</td>
<td>149 (52)</td>
<td>136 (48)</td>
<td>1</td>
<td>1</td>
<td>0.6, 1.5</td>
</tr>
<tr>
<td>Used/touched toilet</td>
<td>389</td>
<td>59 (58)</td>
<td>184 (64)</td>
<td>104 (36)</td>
<td>6</td>
<td>0.8</td>
<td>0.5, 1.3</td>
</tr>
<tr>
<td>Location B (mile 25, airstrip)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used/touched spigot</td>
<td>381</td>
<td>35 (36)</td>
<td>120 (42)</td>
<td>164 (58)</td>
<td>6</td>
<td>0.8</td>
<td>0.5, 1.2</td>
</tr>
<tr>
<td>Used/touched toilet</td>
<td>389</td>
<td>36 (36)</td>
<td>105 (36)</td>
<td>183 (64)</td>
<td>0</td>
<td>1</td>
<td>0.6, 1.6</td>
</tr>
<tr>
<td>Location C (mile 67, airstrip)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used/touched spigot</td>
<td>380</td>
<td>31 (32)</td>
<td>89 (31)</td>
<td>194 (69)</td>
<td>1</td>
<td>1</td>
<td>0.6, 1.7</td>
</tr>
<tr>
<td>Used/touched toilet</td>
<td>389</td>
<td>24 (24)</td>
<td>77 (27)</td>
<td>211 (73)</td>
<td>3</td>
<td>0.9</td>
<td>0.5, 1.5</td>
</tr>
<tr>
<td>Ate at Area C</td>
<td>382</td>
<td>11 (11)</td>
<td>89 (89)</td>
<td>256 (91)</td>
<td>2</td>
<td>1.2</td>
<td>0.6, 2.6</td>
</tr>
<tr>
<td>Location D (mile 100, river exit site)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used/touched spigot</td>
<td>379</td>
<td>4 (4)</td>
<td>14 (5)</td>
<td>268 (95)</td>
<td>1</td>
<td>0.8</td>
<td>0.2, 2.7</td>
</tr>
<tr>
<td>Used/touched toilet</td>
<td>389</td>
<td>23 (23)</td>
<td>84 (29)</td>
<td>204 (71)</td>
<td>6</td>
<td>0.7</td>
<td>0.4, 1.2</td>
</tr>
<tr>
<td>Drank filtered creek water</td>
<td>363</td>
<td>31 (33)</td>
<td>73 (27)</td>
<td>197 (73)</td>
<td>6</td>
<td>1.4</td>
<td>0.8, 2.2</td>
</tr>
<tr>
<td>Drank filtered river water</td>
<td>378</td>
<td>69 (70)</td>
<td>106 (38)</td>
<td>174 (62)</td>
<td>32</td>
<td>3.9</td>
<td>2.4, 6.4</td>
</tr>
<tr>
<td>Drank unfiltered creek water</td>
<td>385</td>
<td>17 (17)</td>
<td>65 (23)</td>
<td>221 (77)</td>
<td>6</td>
<td>0.7</td>
<td>0.4, 1.3</td>
</tr>
<tr>
<td>Drank unfiltered river water</td>
<td>390</td>
<td>5 (5)</td>
<td>282 (98)</td>
<td>9 (2)</td>
<td>3</td>
<td>2.4</td>
<td>0.6, 9.7</td>
</tr>
<tr>
<td>Went into a natural hot spring</td>
<td>395</td>
<td>79 (78)</td>
<td>252 (86)</td>
<td>41 (14)</td>
<td>9</td>
<td>0.6</td>
<td>0.3, 1.0</td>
</tr>
<tr>
<td>Ate at area restaurant posttrip</td>
<td>395</td>
<td>64 (63)</td>
<td>185 (63)</td>
<td>108 (37)</td>
<td>0</td>
<td>1</td>
<td>0.6, 1.6</td>
</tr>
</tbody>
</table>

OR = odds ratio; CI = confidence interval.

*Number of respondents to the online questionnaire.
the Salmon River under USFS-issued rafting permits, indicating that 6.6% of possible respondents answered the survey. Of these 490 persons, 91 (19%) were excluded from the study for not having rafted during July 1–September 23. Moreover, four respondents were excluded for reporting influenza-like symptoms and no gastrointestinal symptoms. Of the resulting 395 respondents, 102 (25.8%) met the case definition and 293 (74.2%) met the control definition and thus were included in the unmatched case-control study. Among case subjects, illness onset was throughout July and August (Figure 1). Study participants’ ages ranged from 10 to 85 years. The male to female ratio and mean age did not differ significantly between case subjects (32 [31.4%] female; mean age = 45.5 years) and control subjects (121 [41.3%] female; mean age = 49.7 years) (p-value = .08 and p-value = .06, respectively). Among the 102 cases, 1 was missing symptom duration; 63 (62%) met the norovirus-like gastroenteritis case definition; and 38 (38%) met the Giardia-like gastroenteritis case definition.

**Case-Control Study**

No association was identified between illness and exposure to hot springs; meals before, during, and after the trip; spigot or toilet use along the river; or rafting group size. In all, 69 (39.4%) of 175 rafters became ill after drinking filtered river water (odds ratio [OR] = 3.9; 95% confidence interval [CI] [2.4, 6.4]) (Table 1). The association between illness and drinking filtered river water was stronger among the 63 norovirus-like gastroenteritis cases (OR = 6.6; 95% CI [3.3, 12.9]) compared with the 38 Giardia-like gastroenteritis cases (OR = 2.2; 95% CI [1.1, 4.3]).

**Clinical Investigation**

Among the 102 case-patients, 75 (73.5%) had nausea; 51 (50%) had vomiting; and 80 (78.4%) had diarrhea. Median symptom duration was 2 days (range: 1–49 days). In all, 23 (22.5%) case subjects reported seeking medical attention; of these, 13 (56.5%) reported having had clinical specimens submitted for laboratory testing. In questionnaire responses, three rafters who were non-Idaho residents reported *Giardia* as their laboratory test result. Laboratory results received on seven rafters who were Idaho residents confirmed detection of *Giardia* in stool (n = 4), norovirus in stool (n = 2), and vomitus (n = 1). Real-time PCR results from the vomitus specimen detected norovirus genogroup I. Sequencing performed on one of the stool specimens detected norovirus genotype L8.

**Environmental Investigation**

Table 2 summarizes the laboratory test results of the environmental samples. Water samples tested negative for *Giardia* cysts and Cryptosporidium oocysts. *E. coli* and total coliforms were detected in samples from a tap and a surface water source at Location C. Norovirus genogroup II was detected in swabs of outhouse and spigot surfaces at Location A.

**Follow-Up Study**

**Drinking Water Treatment Methods**

During March 5–April 5, 2014, a total of 106 participants responded to the follow-up questionnaire; of these, 33 (31.1%) were case subjects and 73 (68.9%) control subjects. Sixteen (48.5%) case subjects and 37 (50.7%) control subjects reported treating drinking water. Of these, six (37.5%) case subjects and 13 (35.1%) control subjects reported that they did not allow for any sedimentation before treating water for drinking, although they reported that little sediment was present in the water; 2 (12.5%) case subjects and 15 (40.5%) control subjects boiled their drink-

---

**Table 2: Laboratory Results From Environmental Samples Collected at Locations Along the Middle Fork of the Salmon River—Idaho, 2013**

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Sample Type</th>
<th>Collection Date</th>
<th>Sample</th>
<th>E. coli</th>
<th>Total Coliforms</th>
<th>Giardia Cysts</th>
<th>Cryptosporidium Oocysts</th>
<th>Norovirus (Genogroup)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Spigot 1</td>
<td>Water</td>
<td>8/11/13</td>
<td>Absent</td>
<td>Absent</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td>Spigot 2</td>
<td>Water</td>
<td>8/11/13</td>
<td>Absent</td>
<td>Absent</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td>Spigot 1</td>
<td>Surface swab</td>
<td>9/24/13</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>Positive (II)</td>
</tr>
<tr>
<td>Spigot 2</td>
<td>Surface swab</td>
<td>9/24/13</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>Positive (II)</td>
</tr>
<tr>
<td>C</td>
<td>Water</td>
<td>10/1/13</td>
<td>Absent</td>
<td>13.4 MPN/100 mL</td>
<td>652.3 MPN/100 mL</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>10/21/13</td>
<td>&lt;1 MPN/100 mL</td>
<td>59.8 MPN/100 mL</td>
<td>NT</td>
<td>NT</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>River (downstream)</td>
<td>Water</td>
<td>10/1/13</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>E Springs</td>
<td>Water</td>
<td>9/30/13</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>F Springs</td>
<td>Water</td>
<td>10/1/13</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
</tbody>
</table>

NT = not tested; MPN = most probable number.

Note: Locations are listed in order of river flow from launch to exit. Springs refer to cold water springs from which rafters reported collecting water for drinking (two samples were taken from each spring and pooled before testing). Water samples were tested only for the presence of *Giardia cysts* and *Cryptosporidium oocysts*. 

![Table 2](https://example.com/table2.png)
ing water (Table 3); all reported boiling ≥1 min. Boiling drinking water ≥1 min had a statistically significant protective effect against illness (OR = 0.2; 95% CI [0.03, 0.9]). All 16 (100%) case subjects and 26 (70.3%) control subjects had filtered their drinking water. Of these, only 3 (19%) case subjects and 3 (11.5%) control subjects knew the pore size of their filters; 1 (6.3%) case-patient and 7 (26.9%) control subjects did not replace their filter cartridge because it looked clean. In all, 12 (75%) case subjects and 17 (65.4%) control subjects did not treat their water with chemicals after filtering.

Of the 20 respondents who treated their water with chemicals, all waited 1–5 min after treatment to consume the water. No case subjects or control subjects reported their water being cloudy before treatment. Zero case subjects and 4 control subjects used ultraviolet (UV) light to treat their drinking water, and all used it on ≤1 L of water, the maximum volume recommended for purifying water with UV penlights by popular commercial manufacturers (e.g., SteriPEN, CamelBak). Zero case subjects and 4 control subjects reported doing a combination treatment: 1 control subject filtered, then used chemicals; and 3 control subjects filtered, then used UV light. Water from multiple spigots along the river was used directly by case subjects and control subjects (without using a detergent or sanitizer) to do a final rinse on their dishes and utensils, to brush their teeth, and to drink.

**Backcountry Sanitation**

No statistically significant association existed between frequency of hand hygiene before handling water treatment equipment and illness. One rafter reported “most people think that the river water is clean and they do not wash with soap or use wipes before eating or drinking.” Furthermore, 82 (77.4%) of 106 rafters reported never running out of soap and water in portable hand washing stations; however, 21 (19.8%) rafters reported never having encountered such stations. Many raf-

**TABLE 3**

Potential Risk Factors for Gastrointestinal Illness Among Rafters Responding to Follow-Up Survey, Middle Fork of the Salmon River (N = 106: 33 Case Subjects and 73 Control Subjects)—Idaho, 2013

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Case Subjects</th>
<th>Control Subjects</th>
<th>Difference in % Exposed</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used river, creek, or spring water to rinse dishes/utensils without soap</td>
<td>97 (19)</td>
<td>10 (15)</td>
<td>4</td>
<td>1.3</td>
<td>0.4, 4.1</td>
</tr>
<tr>
<td>Used spigot water to rinse dishes/utensils without soap</td>
<td>93 (38)</td>
<td>15 (23)</td>
<td>15</td>
<td>2</td>
<td>0.8, 5.1</td>
</tr>
<tr>
<td>Used river, creek, or spring water to brush teeth</td>
<td>102 (10)</td>
<td>9 (13)</td>
<td>3</td>
<td>0.7</td>
<td>0.2, 2.9</td>
</tr>
<tr>
<td>Used spigot water to brush teeth</td>
<td>101 (32)</td>
<td>21 (68)</td>
<td>6</td>
<td>1.4</td>
<td>0.5, 3.5</td>
</tr>
<tr>
<td>Drank water directly from river, creek, or spring</td>
<td>104 (16)</td>
<td>27 (84)</td>
<td>5</td>
<td>0.7</td>
<td>0.2, 2.1</td>
</tr>
<tr>
<td>Drank water directly from spigot</td>
<td>99 (50)</td>
<td>33 (48)</td>
<td>2</td>
<td>1.1</td>
<td>0.5, 2.6</td>
</tr>
<tr>
<td>Reported treating water for drinking</td>
<td>106 (48)</td>
<td>37 (51)</td>
<td>3</td>
<td>0.9</td>
<td>0.4, 2.1</td>
</tr>
<tr>
<td>By filtering</td>
<td>53 (100)</td>
<td>0 (0)</td>
<td>30</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>By boiling</td>
<td>49 (13)</td>
<td>15 (45)</td>
<td>32</td>
<td>0.2</td>
<td>0.03, 0.9</td>
</tr>
<tr>
<td>By using chemicals</td>
<td>53 (19)</td>
<td>17 (68)</td>
<td>27</td>
<td>0.3</td>
<td>0.1, 1.1</td>
</tr>
<tr>
<td>By using ultraviolet (UV) penlight</td>
<td>53 (0)</td>
<td>4 (11)</td>
<td>11</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Reported knowing how other(s) treated their water</td>
<td>53 (35)</td>
<td>12 (33)</td>
<td>2</td>
<td>1.1</td>
<td>0.3, 3.7</td>
</tr>
<tr>
<td>Other(s) filtered their water</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Other(s) boiled their water</td>
<td>18 (33)</td>
<td>0 (0)</td>
<td>12</td>
<td>33</td>
<td>–</td>
</tr>
<tr>
<td>Other(s) added chemicals to their water</td>
<td>18 (50)</td>
<td>3 (25)</td>
<td>9</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Other(s) used UV on their water</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Hand sanitizer was always available</td>
<td>105 (91)</td>
<td>10 (14)</td>
<td>5</td>
<td>1.6</td>
<td>0.4, 6.3</td>
</tr>
<tr>
<td>Hand washing stations were always stocked</td>
<td>85 (93)</td>
<td>2 (7)</td>
<td>5</td>
<td>0.2</td>
<td>0.02, 2.5</td>
</tr>
<tr>
<td>Received or saw any health and safety educational materials</td>
<td>75 (71)</td>
<td>17 (29)</td>
<td>4</td>
<td>1.2</td>
<td>0.4, 3.5</td>
</tr>
</tbody>
</table>

OR = odds ratio; CI = confidence interval.
tters, 92 (86.8%), reported having hand sanitizer available throughout their trip.

**Educational Materials**

Guidelines for gastrointestinal illness prevention, including sanitation, food handling, and water treatment, were created and disseminated to rafters throughout the outbreak. From the follow-up online survey, of 51 (48.1%) rafters who reported that they were exposed to these health education materials, 47 (92.2%) believed they were helpful.

**Discussion**

Our investigation of a gastroenteritis outbreak among rafters at Idaho’s Middle Fork of the Salmon River during July–August 2013 indicated no single cause or source. Both *Giardia* and norovirus were detected among ill rafters, and norovirus, *E. coli*, and total coliforms were detected from environmental samples. Factors that most likely contributed to the spread of gastrointestinal illness included environmental contamination and consumption of inadequately treated water. Gastroenteritis outbreaks have been reported among rafters of the Colorado River (Jones, Gaither, Kramer, & Gerba, 2009; Malek et al., 2009) and for those where the etiologic agent was confirmed, were as a result of norovirus contamination. To our knowledge, our report is the first published account of a gastroenteritis outbreak among whitewater rafters in the U.S. with illness associated with multiple etiologies.

Identifying an outbreak source in this type of setting is challenging. Public health officials investigating a gastrointestinal illness outbreak that occurred during a whitewater rafting trip at the Zambezi River in Africa in 2008 never identified a source, citing lack of knowledge of food consumed. Potential risk factors listed were inadequate sanitation and hygiene, lack of safe food storage, unsafe water usage, inadequate toilet facilities, and exposure to potentially contaminated river water (Nishoe et al., 2009). Three of the six investigations of gastrointestinal illness outbreaks associated with rafting the Colorado River during 1994–2005 could not identify a source (Jones et al., 2009). Not identifying the outbreak source, a common limitation, hampers control and prevention, and dilutes public health prevention messages.

Although our investigation did not find spigot or toilet use to be a statistically significant risk factor for illness, detection of norovirus from swabs of spigot and outhouse surfaces supports the hypothesis that viral transmission might still have occurred through contact with these commonly touched contaminated surfaces. Norovirus can survive on surfaces and in water for weeks to months (Boone & Gerba, 2007; Seitz et al., 2011).

In this investigation, *E. coli* detected in surface water used for drinking indicated the presence of fecal contamination, which can be a norovirus or *Giardia* source as well. Absence of *E. coli* detection in the surface water, however, does not indicate that norovirus or *Giardia* is not present (Harwood et al., 2005). Detection of *Giardia* cysts and two different norovirus genogroups in this outbreak adds to the challenges in pinpointing a common source. A possible explanation for the different genogroups of norovirus detected might be that human stool samples were submitted weeks before environmental samples were obtained, and that different norovirus strains were introduced into the environment at different times.

Drinking filtered water from Idaho’s Middle Fork of the Salmon River during July–August 2013 was a statistically significant risk factor for illness. This association was stronger for case subjects who had a shorter duration of illness (≤3 days), characteristic of norovirus infection. Noroviruses have a particle size of 27–38 nm, whereas a typical drinking water filter removes larger particles sized >0.1–0.2 µm. To remove norovirus, a water filter would need to filter particles sized ≤0.027 µm.

If additional treatment to inactivate norovirus is not performed, as was the case in our outbreak, this might explain why the association between drinking filtered water from the river was higher for illness of shorter rather than longer duration. *Giardia* particles are larger (10–15 µm) than norovirus and would not pass through typical water filters. Further analysis of rafters’ reported water treatment practices confirmed that filters were inadequate in making the backcountry water safe for drinking when used without further treatment. We determined that the only effective surface water treatment method used was boiling, but only a small proportion of rafters had boiled their drinking water. The majority of rafters filtered but did not chemically treat their water after filtering.

Limitations of our study include selection of a nonrandom sample of rafters to participate in the case-control study. We had contact information for permit holders, but not for all persons who rafted the river; consequently, we relied on the permit holders to further distribute the online questionnaire to their fellow rafters. Moreover, dissemination of the questionnaire to the majority of rafters and completion was dependent on the participant rafter having Internet access. Additionally, few reported illnesses were laboratory-confirmed; therefore, other etiologic agents might have been present but undetected.

Past the launch site, the Middle Fork of the Salmon River is accessible only by rafting, hiking, pack animal, and chartered or private aircraft, highlighting the importance of disseminating public health messages before launching. Frequent disinfection of environmental surfaces with an approved disinfectant for norovirus could prevent exposures from contaminated surfaces that are often touched, including spigot handles, oars, rafts, life jackets, and human waste containers (e.g., unimproved metal ammunition boxes, known as "groovers"). Sodium hypochlorite (chlorine bleach) or another product registered by the U.S. Environmental Protection Agency as being effective against norovirus is recommended (U.S. Environmental Protection Agency, 2017). Quaternary ammonium compounds are less effective and should not be used for norovirus disinfection.

Familiarity with filter options (e.g., pore size, shelf life), as well as replacing and cleaning filters according to manufacturer’s recommendations are strongly advised. Increasing public awareness that natural bodies of water are not clean or pristine might lead rafters to improve their backcountry drinking water treatment methods. Despite survey participants reporting not having received or seen any disseminated public health educational materials, those who did see materials reported that they were helpful. During June 2014, the Middle Fork Outfitters Association, with assistance from public health officials, created and disseminated a handout on norovirus infection prevention to guides and clients. USFS installed sanitizer dispensers and outfitter-donated hand washing stations outside outhouses. USFS briefings to rafters before launching stressed that rafters should drink water only...
from approved water systems or water that is filtered, highlighted that filters alone will not guarantee protection, reminded rafters about hand washing after using waste containment systems, and recommended that rafters try not to vomit in the river but instead on vegetated land if they got sick during their trip. During the 2014 rafting season, no gastroenteric disease outbreaks on the Middle Fork of the Salmon River were reported.

Disclaimer: The findings and conclusions in this article are those of the author(s) and do not necessarily represent the official position of CDC.

References


CORRESPONDING AUTHOR: Mariana Rosenthal, Center for Health Statistics, Division of Disease Control and Health Statistics, Washington State Department of Health, 101 Israel Road SE, Tumwater, WA 98501. E-mail: mariana.rosenthal@doh.wa.gov.
References


Did You Know?

Water quality is a major area of focus for NEHA. Our water quality page is always being updated with new e-learning opportunities, relevant topics, and upcoming events and webinars. Check it out today and learn more at www.neha.org/eh-topics/water-quality-0.
Incidence of Non-Hodgkin Lymphoma and Residential Proximity to Superfund Sites in Kentucky

Abstract Non-Hodgkin lymphoma (NHL) is currently the eighth most common cancer in the U.S., the sixth most common cancer among males, and the seventh most common cancer among females (U.S. Cancer Statistics Working Group, 2016). Kentucky has the fourth highest NHL death rate (National Cancer Institute, 2014), and parallels the national and international Western trends of increased incidence in the mid-20th century across all sexes and age groups, with the highest overall rates seen in White males (Al-Hamadani et al., 2015; Devesa & Fears, 1992). The rise in NHL incidence, in the U.S. and Kentucky, appears to coincide with the increased use and dispersion of specific chemical substances into the environment, although support for such an association is difficult to establish. Xenobiotics can function as immune system suppressors and immune suppression is a primary known risk factor for NHL (Engels et al., 2005; Freeman & Kohles, 2012; Grulich, Vajdic, & Cozen, 2007; Vajdic et al., 2009). Exposures to lymphomagenic substances can trigger immunosuppressive conditions (Fisher & Fisher, 2004), although persons with a history of allergies, other hyperimmune disorders, or asthma appear to have a reduced risk of developing NHL (Hofmann, Hoppin, Blair, Alavanja, & Freeman, 2014; Pahwa et al., 2012; Zhou & Yang, 2015).

Introduction Residential neighborhoods located in proximity to Superfund sites, sometimes designated as “high exposure” areas, have higher reports of neurological symptoms than areas with lower exposure (Dayal, Gupta, Trieff, Maieron, & Reich, 1995). Meta-analysis showed that serum immunoglobulin A levels were consistently, but not significantly, elevated for residents near Superfund sites compared with matched controls at least 5 miles away from sites (Williamson et al., 2016). Elevated incidence rates for multiple cancers were also found in areas neighboring a Superfund site in Massachusetts (Ozonoff, Aschengrau, & Coogan, 1994). Another study estimated that multistate Superfund site cleanup activities reduced the rate of infant congenital abnormalities by 20% to 25% for mothers who resided 5 km or less from the sites (Carrrie, Greenstone, & Moretti, 2011). Tree bark samples within 10 km of a Superfund site in Michigan showed 10- to 100-fold increases in dichlorodiphenyltrichloroethane (DDT), hexabromobenzene, and polybrominated biphenyls compared with sites located beyond 10 km (Peverly, Salamova, & Hites, 2014). Geospatial analysis was used to identify clusters of childhood cancer near Superfund sites in Dade County, Florida (Kearney, 2008), of very low birth weight near multiple Superfund sites in Harris County, Texas (Thompson, Bissett, & Sweeney, 2014), and to investigate and confirm the unequal burden of Superfund sites among specific racial, ethnic, and socioeconomic demographics (Burwell-Naney et al., 2013; Heitgerd & Lee, 2003; Maantay, 2002; Maranville, Ting, & Zhang, 2009; Pais, Crowder, & Downey, 2014). The siting of Superfund sites in neighborhoods with lower value housing disproportionately affects poor and primarily minority populations (Greenstone & Gallagher, 2008; Ringquist, 2005; Smith, 2009; Szasz & Meuser, 1997; Szasz & Meuser, 2000).

There are only a few published studies on the possible link between residential proximity to hazardous waste sites and NHL cancer cases. One study in Georgia found that residential proximity to areas where benzene had been released and documented in the U.S. Environmental Protection Agency (U.S. EPA) Toxics Release Inventory resulted in a significant increase in NHL incidence (Bulka et al., 2013). Another found that NHL rates were significantly elevated near National Priority Contaminated Sites in Italy (Comba et al., 2014). Studies that examined NHL rates near uranium milling operations in New Mexico (Boice, Mumma, & Blot, 2010) and rates for a specific type of NHL (cutaneous T-cell lymphoma) in Pennsylvania (Moreau, Buchanich, Geskin, Akilov, & Geskin, 2014) did not show higher rates near hazardous sites. Various state and federal health agencies have been tasked to examine possible NHL clusters near Superfund sites, and confirmed higher than expected rates of NHL in all populations near sites in Ohio (Fercon & Frey, 2008), Texas (Texas Department of State Health Services, 2015), California (Greater Bay Area Cancer Registry, 2012), and in females near a site in Connecticut (State of Connecticut Department of Public Health, 1997).
Methods

Following approval of the Institutional Review Board of the University of Kentucky, NHL cancer data for 1995–2012, including 14,373 records, were obtained from the Kentucky Cancer Registry (KCR). All individual identifying data, except for the geographic coordinates for the patients’ residence, were removed by KCR staff. While 82.3% of NHL cases could be assigned to census tracts based on high-quality residential geospatial coordinates, the remaining 17.7% used the centroid of residential ZIP code because the patient’s recorded address was on rural routes or a post office box.

Census Tract Topologically Integrated Geographic Encoding and Referencing (TIGER) file and basic population data were obtained from the 2010 U.S. Census website; 734 of the 1,115 census tracts in Kentucky had incident cases of NHL at some time between 1995–2012. On average, census tracts in Kentucky had 4,105 people (standard deviation [SD] = 1,721) with a median of 3,920 people. The 18-year cumulative number of NHL cases per 100,000 at census tract-level was on average 210 (SD = 336) with a median value of 28.5. The 1995–2012 crude cumulative incidence rate for NHL in Kentucky was 331.2 per 100,000 people, while the adjusted rate was 305.2 per 100,000 people.

The environmental exposure was measured by proximity to one or more Superfund sites in Kentucky. There were 133 Superfund sites for which geospatial data was available on the U.S. EPA Superfund website for Region 4 (U.S. EPA, 2017); 970 census tracts in Kentucky did not have a Superfund site within their borders, and the remaining 145 had one to five Superfund sites per tract. The exposure areas were developed in ArcMap by drawing 5 km and 10 km buffers around each Superfund site. When buffers of neighboring Superfund sites intersected, they were dissolved into a single area of exposure, and the perimeter of all of the conjoined buffers became the boundary of the newly created exposure areas. Similarly, the 10 km buffers form a ring around the buffers of 5 km exposure areas. Therefore, the exposure areas have different sizes and shapes, including different numbers of census tracts or fragments of census tracts, and different numbers of Superfund sites within their boundaries.

There were 71 areas of exposure within 5 km of one or more Superfund sites, and 45 areas located in the ring around the buffers between 5 km–10 km. For the census tract fragments with missing values, the same cumulative incidence rate of the exposure area was imputed. Finally, the remaining areas of the state, outside the 5 km and 10 km exposure areas, formed the third area of interest, the “unexposed” areas of the state, for which the incidence rates were computed at census tract-level.

TABLE 1

Descriptive Statistics for Patient Data (N = 14,373)

<table>
<thead>
<tr>
<th>Demographics</th>
<th>#</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>6,978</td>
<td>48.5</td>
</tr>
<tr>
<td>Male</td>
<td>7,395</td>
<td>51.5</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>13,617</td>
<td>94.7</td>
</tr>
<tr>
<td>Black</td>
<td>632</td>
<td>4.4</td>
</tr>
<tr>
<td>Other/unknown</td>
<td>124</td>
<td>0.9</td>
</tr>
<tr>
<td>Age at diagnosis (year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–9</td>
<td>61</td>
<td>0.4</td>
</tr>
<tr>
<td>10–19</td>
<td>127</td>
<td>0.9</td>
</tr>
<tr>
<td>20–29</td>
<td>221</td>
<td>1.5</td>
</tr>
<tr>
<td>30–39</td>
<td>583</td>
<td>4.1</td>
</tr>
<tr>
<td>40–49</td>
<td>1,300</td>
<td>9.0</td>
</tr>
<tr>
<td>50–59</td>
<td>2,392</td>
<td>16.6</td>
</tr>
<tr>
<td>60–69</td>
<td>3,546</td>
<td>24.7</td>
</tr>
<tr>
<td>≥70</td>
<td>6,143</td>
<td>42.7</td>
</tr>
<tr>
<td>Tumor type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intranodal NHL</td>
<td>10,181</td>
<td>70.8</td>
</tr>
<tr>
<td>Extranodal NHL</td>
<td>4,192</td>
<td>29.2</td>
</tr>
<tr>
<td>Family history of NHL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>7,495</td>
<td>52.2</td>
</tr>
<tr>
<td>Yes</td>
<td>533</td>
<td>3.7</td>
</tr>
<tr>
<td>Unknown</td>
<td>6,345</td>
<td>44.1</td>
</tr>
<tr>
<td>Appalachia region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>10,337</td>
<td>71.9</td>
</tr>
<tr>
<td>Yes</td>
<td>4,036</td>
<td>28.1</td>
</tr>
<tr>
<td>Beale Code classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>12,997</td>
<td>90.4</td>
</tr>
<tr>
<td>Rural</td>
<td>1,376</td>
<td>9.6</td>
</tr>
<tr>
<td>Residential proximity to nearest superfund site (km)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>4,225</td>
<td>29.4</td>
</tr>
<tr>
<td>5–10</td>
<td>3,570</td>
<td>24.8</td>
</tr>
<tr>
<td>&gt;10</td>
<td>6,578</td>
<td>45.8</td>
</tr>
</tbody>
</table>

NHL = non-Hodgkin lymphoma.
The outcome of interest in this study is the age-adjusted cumulative incidence rate of NHL per 100,000 persons in Kentucky. The age-adjusted cumulative rates of NHL were estimated with the direct method for the exposure areas and for all census tracts outside the exposure areas, using the 2000 U.S. Census standard population weights per 100,000 per current recommendations from the Centers for Disease Control and Prevention (Anderson & Rosenberg, 1998; Klein & Schoenborn, 2001). The patient’s residential proximity to Superfund sites was measured by the exposure within 5 km, exposure between 5 km and 10 km, as compared with the exposure beyond 10 km, which was the reference group for the analyses.

Traditional statistics were used to describe the patient population, and to test for bivariate associations between the incidence rates and potential explanatory factors available in the dataset. The multivariable association between the exposure and the cumulative incidence rate of NHL per 100,000 persons was measured with spatial regression. Race, smoking status, and NHL family history were tested in the bivariate models but were not retained in the multivariable models due to the very small variation in the data and large proportions of missing values. Diagnostic tools for spatial autocorrelation and clustering confirmed the need for a geographically weighted regression approach.

Results

There were 14,373 new NHL cases in Kentucky between 1995–2012 (Table 1), of which 42.7% were diagnosed at age 70 or later and another 24.7% were diagnosed with NHL in their 60s; over 90% of the NHL patient population resided in urban areas. The patient population included 51.5% males and 94.7% of all cases were White. Intranodal NHL accounted for 70.8% of all cases, 71.7% of male cases, and 69.9% of female cases. Of all cases that were of other than White race, only 0.6% were Hispanic or Latino of any race (data not shown) and 4.4% were African American. In accordance with national NHL statistics, 67.4% of all diagnoses occurred in patients age 60 or older. Only 3.7% of the patients had a known prior family history of NHL and 52.2% had no prior family history; data were missing for 44.1% of the caseload. Only 28.1% of patients lived in counties that were part of the designated region of Appalachia and 9.6% of patients lived in rural areas. Finally, 39.1% of patients were current users of tobacco products.

Bivariate analysis of residential proximity to Superfund sites by demographic variables is presented in Table 2. Nearly 30% of all patients lived within 5 km of a Superfund site, whereas residents of Appalachia or rural areas were less likely to live near them. The percentage of NHL cases with unknown or no family history of NHL were significantly higher for the cases residing within 5 km of Superfund sites. The age-adjusted cumulative NHL incidence rates across exposure groups were significantly greater within 5 km exposure areas than in the other two groups (Table 3); further, the rates within 5 km and 10 km from the Superfund sites were significantly

| TABLE 2
| Distribution of Non-Hodgkin Lymphoma (NHL) Cases by Exposure Group |
|----------------------------------|-----------------|-----------------|-----------------|
| Demographic Variable             | Residential Proximity to Nearest Superfund Site # (%) |
| Gender                           | <5 km | 5–10 km | >10 km |
| Male                             | 2,170 (29.4) | 1,793 (24.2) | 3,432 (46.4) |
| Female                           | 2,055 (29.4) | 1,777 (25.5) | 3,146 (45.1) |
| Race                             | White | Non-White |
| Male                             | 3,826 (28.1) | 3,400 (25.0) | 6,391 (46.9) |
| Female                           | 351 (55.4) | 133 (21.0) | 150 (23.7) |
| Appalachian region               | No | Yes |
| Male                             | 3,459 (33.5) | 3,070 (29.7) | 3,808 (36.8) |
| Female                           | 766 (19.0) | 500 (12.4) | 2,770 (68.6) |
| Beale Code classification        | Urban | Rural |
| Male                             | 4,157 (32.0) | 73 (5.3) | 1,235 (89.8) |
| Female                           | 68 (4.9) | 688 (26.9) | 3,043 (41.1) |
| Family history of NHL            | Yes | No | Unknown |
| Male                             | 133 (25.0) | 2,234 (29.8) | 1,858 (29.3) |
| Female                           | 130 (24.4) | 1,817 (24.2) | 1,623 (25.6) |
| SEER type                        | Intranodal | Extranodal |
| Male                             | 2,969 (29.2) | 2,547 (25.0) | 4,665 (45.8) |
| Female                           | 1,256 (30.0) | 1,023 (24.4) | 1,913 (45.6) |

SD = standard deviation

| TABLE 3
| Age-Adjusted 1995–2012 Cumulative Non-Hodgkin Lymphoma (NHL) Incidence Rates by Exposure |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Age-Adjusted NHL Incidence Rates | Exposure Mean (SD) | ANOVA |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                                   | <5 km | 5–10 km | >10 km | F-Statistic | p-Value |
| Overall                           | 457.0 (244.7) | 308.6 (100.6) | 90.9 (215.7) | 17.8 | <.001 |
| Male                              | 542.4 (341.2) | 338.3 (113.3) | 258.8 (249.5) | 21.6 | <.001 |
| Female                            | 382.9 (240.2) | 285.3 (116.7) | 62.4 (303.6) | 5.1 | .006 |
| Intranodal tumor                  | 323.4 (200.2) | 218.7 (73.3) | 08.5 (180.6) | 12.3 | <.001 |
| Extranodal tumor                  | 133.7 (82.8) | 89.9 (49.6) | 82.5 (76.6) | 13.4 | <.001 |

SD = standard deviation
The rates for the unexposed group were significantly lower than those in the exposed groups, at a significance level of $p < .05$.

These data reflect the national trends, in that the male patients have a higher incidence rate than females for both intranodal and extranodal NHL. As expected, an age-related increase in NHL incidence was observed for both males and females, and for both SEER classifications (Surveillance, Epidemiology, and End Results [SEER] Program of the National Cancer Institute), with a sharp increase in NHL for females ages 60–69.

The age-adjusted cumulative incidence rates for NHL per 100,000 persons from 1995–2012 in each census tract and buffer zone around Superfund sites (Figure 1) showed that NHL cumulative incidence rates were slightly higher in the western and south-central regions of Kentucky.

Stationarity tests showed that the predictor effects on the outcome were not consistent across the studied area, and the Global Moran’s I indicated the presence of spatial autocorrelation among residuals. All z-scores were significant and positive, indicating significant autocorrelation and clustering of similar residual values. Hot spot analysis identified the areas of significant high or low spatial clustering of NHL incidence data using the Getis-Ord $G^*_i$ statistic at the 99%, 95%, and 90% confidence limits (Figure 2).

Exploratory regression using ordinary least squares (OLS) showed that urbanicity or rurality of an area is a significant predictor for the NHL cumulative incidence rate—but residence in the Appalachian region was not (data not shown). This finding is interesting, as the Appalachian region is generally known to have significantly higher cancer incidence rates than the rest of the state. The OLS models explained a small amount of the variability around the fitted regression line, with a coefficient of determination of about 7%; they had acceptable levels for the variance inflation coefficients, but significant Koenker (BP) statistics indicate nonconsistent relationships between the dependent and independent variables (nonstationarity); thus, geographically weighted regression (GWR) was more appropriate than the OLS models. For GWR models, adaptive kernel density estimation was utilized, along with the corrected Akaike information criterion (AIC) to estimate bandwidth. The AIC’s values were compared between the GWR models; the lower AIC value was from the GWR all-case base model ($AIC = 24,893.8$), indicating that this was the model that best fits the data (Table 4). The GWR models represent a better fit around the regression line than the OLS models, and explain a larger percentage of the variability. The best-fitting model explains approximately 23% of the variability in the overall NHL cumulative incidence rate.
The best-fitting GWR model showed that the confidence interval [CI] rate per 100,000 persons was on average 120.7 (t = 62.59, p < .001) greater within 5 km from Superfund sites than in the areas beyond 10 km, while all other variables were held constant. Similarly, within the areas located between 5 km–10 km the CI rate per 100,000 persons was 45.9 (t = 30.37, p < .001) greater than in the unexposed areas. The patterns and magnitudes of residuals (Figure 3) are not surprising, given that the best-fitting GWR model explained only 23.1% of the variability in the dependent variable. There appear to be more areas of “high” standardized residuals than “low” standardized residuals; the highest magnitude areas, where the observed incidence rates exceeded the predicted rates by more than 2.5 standard deviations, were most prominent in the central and western areas of Kentucky. Low areas, where the observed incidence rates were lower than the predicted rates, were randomly scattered throughout the state.

Discussion
This observational study of the distribution of NHL in Kentucky aimed to identify whether the distribution of NHL incident cases follows a different pattern across the state in relationship with the location of Superfund sites. To the investigators’ knowledge, this question has not been previously examined in Kentucky, or anywhere else in the U.S. while examining important covariates. Geospatial information and tools in public health research extended our ability to examine spatial patterns within existing data, to understand relationships between outcomes and environmental variables, and to make inferences about exposure patterns (Brewer, 2006). The model data support the hypothesis that residential proximity to Superfund sites in Kentucky explains a significant proportion of variance in the distribution of the cumulative incidence rates of NHL, although a large proportion still remains unexplained.

There are limitations to the present study. The cancer records did not include individual indicators associated with the social determinants of health. Socioeconomic and demographic variables at the census-tract level from the 2010 U.S. Census were imputed, however, and were not found to significantly contribute to the association between residential proximity to Superfund sites and NHL incidence rate. The standardized GWR residuals and the $R^2$ values suggest that there are other explanatory variables that contribute to NHL incidence that were not captured in the current investigation due to high proportions of missing data regarding the family history of cancer, smoking, or alcohol use.

For the 133 Superfund sites in Kentucky, data on the site-specific chemicals that led to the site’s Superfund designation were available for only 20 (15.0%) of the sites. Of these 20 sites with chemical data available, 18 contained contaminants that have been associated with an increased risk of NHL, including benzene and benzyl compounds (Mehlman, 2006), lead (Demir et al., 2011), polychlorinated biphenyls (Muller, Ihorst, Mertelsmann, & Engelhardt, 2005), cadmium (Kelly et al., 2013), trichloroethylene (Bassig, Lan, Rothman, Zhang, & Zheng, 2012), organochlorines other than polychlorinated biphenyls (Brown, Rushton, & British Occupational Cancer Burden Study Group, 2012), and perchloroethylene (Vlaanderen et al., 2013).

It should be noted that the U.S. EPA will place a site on the Superfund list only if there

### Geographically Weighted Regression Modeling Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Variables</th>
<th># of Neighbors</th>
<th>Sigma</th>
<th>Akaike's Information Criterion</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>Exposure &lt;5 km</td>
<td>241</td>
<td>155.809</td>
<td>24,893.804</td>
<td>0.231</td>
</tr>
<tr>
<td></td>
<td>Exposure 5–10 km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2</td>
<td>Appalachia region Beale Code</td>
<td>834</td>
<td>163.244</td>
<td>25,047.162</td>
<td>0.134</td>
</tr>
<tr>
<td></td>
<td>Exposure &lt;5 km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exposure 5–10 km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dependent variable: cumulative incidence of non-Hodgkin lymphoma per 100,000 people.
is a plausible threat to human health or the environment. All Superfund sites in the present study were considered as equally likely to contribute environmental exposures that can lead to NHL. This consideration could lead to exposure misclassification, which most likely biases the results toward the null.

Education and awareness campaigns about NHL, risk factors, and symptoms could lead to earlier diagnosis and better outcomes in affected communities. Early detection relies on techniques such as lymph node biopsy, blood cell chemistry and morphology tests, or imaging scans that can detect not just NHL but other hematological malignancies (University of Texas, MD Anderson Cancer Center, 2017). Encouraging people in the communities most affected by NHL to seek screening may improve their health outcomes. Medical research should continue to investigate simple, low-cost, sensitive, and specific methods for detecting NHL, as it will most likely continue to be a cancer of high incidence as the population ages.

**Conclusion**

NHL incidence in the U.S. and many other Western nations increased throughout the 20th century, in a pattern that suggests greater exposure to chemicals might be a causal factor. Mechanistic research suggests many pathways by which chemicals and xenobiotics can trigger NHL. The present study demonstrated that residential proximity to hazardous waste sites in Kentucky could be a significant risk factor for NHL. Additional research, advocacy, and education should focus on mechanisms of NHL incidence, replicating the present study in other contexts and with monitoring data. Further research needs to be done to address upstream factors that lead to unequal burdens of hazardous material exposures and NHL incidences. Additionally, downstream education and awareness, plus better methods for NHL screening and early detection, are also needed.

**Acknowledgements:** The authors wish to thank Eric Durbin and Jaclyn Nee at the Kentucky Cancer Registry for providing the cancer records and for their availability to answer questions as they arose.

**Corresponding Author:** W. Brent Webber, Senior Industrial Hygienist, Environmental Health and Safety Division, University of Kentucky, 252 East Maxwell Street, Lexington, KY 40508. E-mail: brent.webber@uky.edu.

---

**References**


continued on page 28
References continued from page 27


References

Retrieved from https://www.dshs.state.tx.us/epitox/CancerClusters/East-Harris-County-2015.doc

Thank you for Supporting the NEHA/AAS Scholarship Fund

American Academy of Sanitarians
Lawrenceville, GA
James J. Balsamo, Jr, MS, MPH, MHA, RS, CP-FS
Metairie, LA

LeGrande G. Beatson
Farmville, VA
Bruce Clabaugh
Highlands Ranch, CO

George A. Morris, RS
Dousman, WI
Richard L. Roberts
Grover Beach, CA

LCDR James Speckhart, MS
Silver Spring, MD
Leon Vinci, DHA, RS
Roanoke, VA

Choosing a career that protects the basic necessities like food, water, and air for people in your communities already proves that you have dedication. Now, take the next step and open new doors with the Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential from NEHA. It is the gold standard in environmental health and shows your commitment to excellence—to yourself and the communities you serve.

Find out if you are eligible to apply at neha.org/rehs.

A credential today can improve all your tomorrows.
Abstract  Most populations now derive benefits as well as risks from a global economy. Local environmental health can be impacted positively through importation or adoption of foreign technological advances, administrative approaches, and cultural attributes, to name only a few. Similarly, risks are now commonly shared on an international scale, as illustrated by cross-border food source contamination, emerging or recognized disease spread, unchecked international pollution, and a host of other incidents in recent years. Beyond the case study, historical record of the textbook approach, affordable study abroad programs now exist to more concretely educate students about such impacts. Once considered simply a perquisite for more financially able students, or a requirement for language arts students, both short- and full-term study abroad programs increasingly add a necessary global perspective to the college environmental health graduate. This special report details the ways in which a number of accredited programs are using and integrating study abroad experiences into their curriculums to better prepare their graduates to meet the international environmental health and safety challenges of the 21st century.

Introduction
Experience, travel—these are as education in themselves.
— Euripides, 480 B.C.–406 B.C.

As the impact of globalization affects our social, political, and environmental systems, study abroad opportunities have increasingly become an academic priority both for students and for the college programs in which they are enrolled (Blake-Campbell, 2014). Formerly populated mostly by language studies or cultural exchange students, long-term study abroad programs are in decline relative to the growth of programs of shorter duration (Dwyer & Peters, 2000), with almost 2 out of every 3 study abroad courses lasting less than 8 weeks (Institute of International Education [IIE], 2016a). Students come from a diverse array of academic study areas. For the most recent academic year reported (2014–2015), the greatest numbers were from science, technology, engineering, and math (24%); business (20%); social sciences (17%); foreign languages (8%); and fine and applied arts (7%) (IIE, 2016b). In total, 313,415 U.S. students went abroad to study in the 2014–2015 academic year, roughly a 3% increase from the preceding year (IIE, 2016b).

It will probably surprise few that global perspectives are being assimilated into the K-12 curriculum of U.S. schools. According to the National Education Association (2010), “three states—California, North Carolina, and Ohio—are starting to integrate international perspectives into the classrooms.” Several states with historically strong teacher college education systems now host universities offering globally oriented teacher preparation courses as well. These schools include Indiana University, Michigan State, Ohio State, and the University of Wisconsin. Environmental health topics for study in such curriculums are many, and include global health matters such as the pandemic flu, HIV/AIDS, natural disasters and emergency response, and global warming.

At the college level, the academic case has been clearly articulated for the skills and expertise of the environmental health professional in matters with cross-border implications. The National Environmental Health Science and Protection Accreditation Council (EHAC) mandates educational content on the subject of emergency response and the oftentimes-related disaster management of environmental health issues (EHAC, 2010). In their college-level textbook on public health, Tulchinsky and Varavikova (2008) provide a clear listing of the impacts global events can have on domestic and international environmental health practitioners. These events include natural disasters such as hurricanes, droughts and famine, floods, earthquakes, and the ongoing repercussions of volcanic eruptions. They go on to cite a role for environmental specialists in the preparation and organization of services for human-initiated situations such as wars (refugee camps), population displacements (as seen recently as a result of the ongoing Syrian civil war migration), and other disruptions of civil societies worldwide (“Migrant crisis,” 2015). Frumkin (2016), in his text focusing exclusively on environmental health, dedicates four chapters to the international

Timothy J. Ryan, PhD, CIH, CSP
Ohio University
aspects of population, climate change, war, and issues in low-resource countries.

**Methods and Experiences**

Clearly, academicians are aware of and addressing global environmental health impacts. The purpose of this special report, however, is to highlight how a so-called “boots on the ground” curricular element can enhance and improve environmental health education in the U.S. Several examples will be explored, including sustainability in Costa Rica, air pollution in London, and climate change in the Pacific.

Sustainability is perhaps the best example of an immensely significant modern effort essentially unheard of 50 years ago. It has steadily grown in importance to the U.S. global community since its adoption here in the late 1960s (U.S. Environmental Protection Agency, 2017). The concept and attractiveness of sustainability are widely recognized by numerous corporations, nongovernmental organizations, universities, and governments. In their content analysis paper about the International Research in Geographical and Environmental Education, Kidman and Papadimitriou (2012) reported that papers published by that journal related to environmental education increased threefold; those papers following a theme of sustainability, pollution, or global warming (10% of all published papers) showed a steady increase over the period 1992–2009.

The University of Georgia is able to unambiguously demonstrate sustainability as it relates to various co-ops and farms visited in Monteverde, Costa Rica, via its Comparative Environmental Health Program. To connect students to this topic, farms in Georgia and Costa Rica are compared in terms of products grown, methods (e.g., crop rotation, use of topography), and prospects for long-term sustainability. A tangible, intended learning outcome of the study abroad aspect of the course is that students “are able to experience classroom learning applied to local examples” through activities such as stopping along the road and conversing with actual employees or farmers in the area (A.M. Zimeri, personal communication, October 14, 2015).

In the author’s Global Public Health—London course, the topic of air pollution is regularly covered. For this topic, it is arguable if there could be a more historically significant study abroad location selected to fully appreciate the multifaceted aspects of such an environmental health problem. Clearly there exist modern cities where air pollution could be taught with the benefit of real-world, present day examples: Mexico City, Beijing, and Mumbai all represent cities with serious pollution demonstrating adverse health effects. London, with its incredibly long history of development, presents notable air pollution incidents from the past, like the Great Smog (Laskin, 2006), as well as modern technological and political approaches to abatement (Greater London Authority, 2017). In this regard, London constitutes a *prima facie* case where seamless integration of the environmental health message with the study abroad location is possible. As students ride one of the city’s more famous tourist attractions—the London Eye Ferris wheel—they are challenged to identify modern and historically significant sources of pollution that unfold before their eyes as the wheel takes them over 400 feet above the city. At that height, the thousands of now-defunct coal fired chimneys demand to be seen, with their former impact (e.g., environmentally induced scrotal cancer, as determined by Percivall Pott, or the Chimney Sweepers Act of 1788) palpable through their sheer numbers. On the crowded streets below, thousands of mobile sources of NOx, SOx, CO, etc., are equally apparent in the form of buses, heavy trucks, cars, motorcycles, and boats, while overhead the contrails from dozens of aircraft can be visualized under favorable atmospheric conditions.

One great strength of “being present” at a study abroad location, unlike a classroom, is the ability to connect in a meaningful way with historical artifacts. While no one can re-live history or likely get close to the emotional feelings of an event years later, through seeing, handling, or visiting a historically significant aspect of that event, it is entirely possible for the environmental health students to create a modern memory intimately connected to an ancient practice, event, or thing. In this way, the true impact of the past can be experienced firsthand (for the student) in their own individual context.

In the aforementioned London study abroad course, examples of just this sort of phenomena are designed into the course. Students visit the British Museum and see an early lead pipe constructed by the Romans to provide potable water to the population; they visit the John Snow Pub, located just feet away from the very site of the infamous water well and pump (reconstructed nearby, sans handle) implicated by Snow in the 1850s cholera outbreaks; students take a water taxi down the River Thames to Greenwich, observing centuries old (but still in operation) water outfalls into that tidal river, in turn emptying into the ocean; the class attends the London Science Museum observing a contemporaneous diorama of an early microbiology laboratory significant for the identification and control of infectious diseases. Although there are many additional examples, these suffice to demonstrate how “the past can be made present” in a suitably located and prepared study abroad experience.

In a directly analogous approach to that of the London course, students enrolled in the author’s Global Public Health—Costa Rica class get to personally experience environmentally significant aspects of water pollution. As the class begins in the south of the country, along the pristine Pacific Coast, students live for a number of days on a small community water system. The realities of providing fresh, potable water are experienced daily. On several class excursions, notably the “sewer tour,” the class literally follows the gray water discharges from a small community through increasingly larger and more polluted streams, to the ultimate outfall at a tidal basin of the adjacent Pacific Ocean. In this exercise, students are hard-pressed not to appreciate the importance of environmental health regulations, the engineering advances employed for clean water provision, and contamination control.

Global climate change is a frequent, timely, and ever-present topic of concern and discussion in multiple disciplines these days, notably politics, engineering, and environmental health. What better way to illustrate to interested students the impacts of such changes, than to go to locations where they are evident? In the Costa Rica class, an article by researchers from the Centers for Disease Control and Prevention on environmental effects of global climate change (Patz & Frumkin, 2005) is read as part of a class exercise. Students must then reflect upon the content of the reading (e.g., temperature, sea level rise, greenhouse gases, marine systems, vectorborne disease effects, etc.) and relate
the content to the environment in which they are staying. Evidence of the absolute connection between this course element and the study-abroad experience was evident when a student commented in her paper about the receding sea life normally found around the shoreline snorkeling reef. She reported that a local resident had noted that shoreline water temperatures were rising, causing formerly plentiful coral and its associated marine life to recede to off-shore deeper water. Most relevant to this discussion is that the student in fact went snorkeling in the affected area, visualized the dead reef areas, and could see more opulent life further off shore, precisely as the resident had noted (M. Reichert, personal communication, January 3, 2015).

Finally, it might be pointed out that environmental-oriented travel is no longer exclusively the domain of college students in academic programs. In 2013, a Google search listed seven discrete, independent tour providers for the Chernobyl reactor site and contamination zone in Ukraine. Other so-called “dark tourism” sites exist, including Fukushima as well as a variety of environmental (receding glaciers, volcanoes) and nonenvironmental sites (shipwrecks, WWII battlefields, etc.).

While such tours are not stand-alone study abroad courses, it is foreseeable that they might be included in these if deemed of interest to the course program director. What is perhaps most interesting about such tours, however, is that they exist at all. They present clear evidence of a fascination among a variety of backgrounds to see and better understand a specific environmental health story. As such, their very existence constitutes a highly relevant illustration of an environmental health-centered type of learning. In the case of Chernobyl, for instance, what better way to bring home to those travelers the application and importance of the longstanding aspects of radiation safety of time, distance, and shielding.

Discussion

That the global perspective of environmental health is shared by most practitioners of the profession will come as no surprise to many, as the National Environmental Health Association itself has offered global training exchange opportunities for its members for years (NEHA, 2015). What must be impressed upon new professionals, however, is the rapidly developing, interdependent, and inescapably globally linked nature of many modern endeavors. For example, over 10 years ago, the U.S. Department of Commerce pointed out that 20% of jobs in the U.S. were tied to international trade (U.S. Census Bureau, 2005). As of their updated accounting for 2011, this percentage had risen to almost 24%, or roughly 1 out of every 4 jobs in our nation (U.S. Census Bureau, 2013). Notable jobs with obvious environmental health impacts are represented categorically in this data as Food, Beverages, and Chemicals, with international employment links reported as 8.4%, 3.3%, and 30.3%, respectively.

Some benefits of study abroad could equally be seen state-side, if only they were encouraged, required, or more frequent. The University of Georgia’s Professor Anne Marie Zimeri noted that the “shadowing” activity of farm workers employed in her Costa Rica course led to more intense, real-life observations for a given topic back home (A.M. Zimeri, personal communication, October 14, 2015). Clearly the field trips used in U.S. environmental health education, or the practicum requirement of many curricula, can result in a similar intensity and opportunity for learning. Yet the immersive nature of a study abroad course is itself a more passionate experience, leading to more powerful impressions and lasting lessons, and provides “a rich and engaging opportunity for students to learn firsthand” (Blake-Campbell, 2014, p. 62).

While the benefits of environmental health-focused study abroad experiences are clear and demonstrable, cost is an inescapable reality that generally limits any widespread requirement (or even allowance) for their occurrence. Whereas prescriptive environmental health curricula from EHAC mandate coursework in toxicology, epidemiology, and statistics, study abroad has yet to be mentioned in the undergraduate environmental health program accreditation guidelines (EHAC, 2010). Cost could easily be a factor for their exclusion. The EHAC guidelines are just that—guidelines—and are regarded as quite flexible when utilized in a determination of a program’s suitability for accreditation or reaccreditation. Nevertheless, the wholesale lack of acknowledgement for the benefits of study abroad in the environmental health curriculum seems surprising given the universality of environmental health. Given the trend of more readily available, shorter-term (i.e., less expensive) international study abroad opportunities, this lack of acknowledgment is surprising. Quoting Dwyer and Peters (2000) in their survey of past study abroad participants:

In the 1950s and 1960s, 72 percent of respondents studied for a full year, but only 20 percent of respondents did so in the 1990s. The number of students studying for less than 10 weeks tripled from the 1950s and the 1960s to the 1990s.

For the majority of short-term programs, the most significant expenses are airfare and transportation, followed by housing (which typically involves more expensive lodging like hotels or leased apartment blocks, as opposed to the home-stay model used in learning languages). The actual education piece is rarely a significant expense in that tuition and fees are considered part of an existing academic term. For example, a spring break 10-day program will typically be considered within the spring semester. Many schools provide for “free” credits so long as a student is enrolled as a full-time student (e.g., 12 credit minimum) and does not exceed an upper bound (e.g., 20 credits). In this structure, study abroad is clearly a bargain for the student, who would have living expenses in any event, can take advantage of “free” credits, and therefore only needs to plan for the added expense of airfare to complete the study abroad learning experience.

As a final point for an environmentally conscious profession such as ours, it must also at least be acknowledged that any adoption of more active global education must remain sensitive to the impacts such activities might have on the visited sites. For any environmental health study abroad offering, the question of how environmental quality might be affected by the mere presence of the students should be considered prior to travel. Any sort of “environmental paradox” in which the study of an environmental topic could be seen to jeopardize local residents, their environment, or quality of life at the study site should carefully be considered. For example, Skanavis and Sakellari (2011) point out that more developed countries are responsible for the majority of greenhouse gas emissions, but the worst consequences
are felt in countries “lacking the economic capacity and infrastructure to cope.” For an environmental health curriculum, one should consider if the course impact in terms of carbon footprint, transportation emissions, and food, water, and waste provision justify the learning provided by the experience.

**Conclusion**

In a published survey that was not peer reviewed of 3,400 returned students from 1950–1999, Dwyer and Peters (2000) point to positive and unequivocal benefits of all study abroad experiences. Over 95% of all respondents responded affirmatively that their time abroad taught them increased self-confidence, developed their maturity, and had a lasting impact on their worldview. (Equally positive results were confirmed in 2012 by Preston.) From the environmental health perspective, such a worldview can be considered helpful—if not outright essential—in a world of global interactivity and interdependence. For example, in the aftermath of the localized Japanese earthquake and resulting tsunami of March 11, 2011, the global economic and business impacts were quickly felt (Bunkley, 2011). Food security and sourcing, hazardous chemicals and materials disposal, air pollution from stationary and mobile sources, emergency response or mitigation, and global climate change (with its attendant environmental influences) are all highly pertinent examples in which the present-day environmental health practitioner requires sensitivity to the international picture. As such, inclusion of more globally focused study abroad provided-learning experiences from the modern environmental health curriculum must make their way to the students of present day environmental health programs.

**Corresponding Author:** Timothy J. Ryan, Professor, Occupational Hygiene and Safety Program, Ohio University, W355 Grover Center, Athens, OH 45701. E-mail: ryan@ohio.edu.

---

**References**


Cross-Training: It’s Not Just for Athletes!

Nancy Pees Coleman, MPH, PhD, RPS, REHS, DAAS
Environmental Consultants

**Editor’s Note:** In an effort to provide environmental health professionals with relevant information and tools to further the profession, their careers, and themselves, NEHA has teamed up with the American Academy of Sanitarians (AAS) to publish two columns a year in the *Journal*. AAS is an organization that “elevates the standards, improves the practice, advances the professional proficiency, and promotes the highest levels of ethical conduct among professional sanitarians in every field of environmental health.” Membership with AAS is based upon meeting certain high standards and criteria, and AAS members represent a prestigious list of environmental health professionals from across the country.

Through this column, information from different AAS members who are subject-matter experts with knowledge and experience in a multitude of environmental health topics will be presented to the *Journal’s* readership. This column strengthens the ties between both associations in the shared purposes of furthering and enhancing the environmental health profession.

Nancy Pees Coleman is an environmental toxicologist in private practice in Oklahoma City, Oklahoma. She has degrees from Old Dominion University and the University of Oklahoma Health Sciences Center. She has been a diplomate of AAS since 1988.

Athletes do it! Fitness trainers push it! It’s cross-training! Just as athletes are encouraged to pursue cross-training in more than one sport to improve fitness and performance in their main sport, environmental health professionals should be encouraged to cross-train in more than one aspect of their discipline to improve overall competency and performance in environmental health. By the very nature of being the only toxicologist in a health department, an environmental quality department, a consulting firm, and a corporation, cross-training in the various disciplines of environmental health has been mandatory for me to be effective in my position as a toxicologist. Forty years of professional practice have made me realize how important it is for an environmental health professional to understand all the program areas that intersect within environmental health groups or departments.

Cross-training can be a powerful tool for both the organization and the environmental health professional. Just as the team and athlete benefit from cross-training by having better team members, environmental health organizations are stronger and more effective when their environmental health professionals have more overall knowledge about environmental health and safety program areas. A broader understanding of the programmatic areas encourages employees to use a more holistic approach when implementing new projects, developing new regulatory programs, etc. It builds better teamwork within and among program areas as they begin to understand why each is important to the overall mission of the organization. It also makes an organization less vulnerable to disruptions due to employee departures, emergencies, illnesses, or unexpected workloads.

For organizations that have compliance requirements, cross-training yields professionals that can identify issues beyond their individual subject. For example, the food service inspector can recognize that an emergency generator installation at the food processing facility needs an air permit and may also need a spill prevention control and countermeasures plan, a lead-acid battery management plan, an evaluation of potential employee exposure to the combustion exhausts, and a hazardous waste management plan. This comprehensive view can result in better overall environmental health compliance.

Considering the recent trend of manager placement over areas in which they have little or no competency, cross-training helps to build better managers. One of my sons...
worked for 20 years for a company that was divided into three major program areas. An entry-level employee worked a minimum of 9–12 months in each of the program areas. Only then was an employee eligible to be promoted to a management level. Each program area was managed for a year to gain experience managing each of the areas before becoming eligible for promotion to the next management level. By the time someone reached the upper levels of management, they knew how to do every job in the company. Cross-training makes for better managers and better decision making by those managers. The major barrier to this rotational approach is the highly specialized and complex nature of environmental health tasks. It often takes a year or more to bring a new professional up to a minimum level of competency. In these instances, cross-training could be accomplished by job sharing between employees on a temporary basis (e.g., a couple of hours per week), short duration assignments of two to four weeks, or a voluntary two-year rotation plan. For highly specialized positions, cross-training may only cover a portion of the job that can be reasonably shared.

Cross-training can also be helpful between field environmental health professionals and those located in the central agency or corporate office. By nature of the job, field environmental health professionals have more opportunity for on-the-job cross-training because of the diverse programmatic responsibilities of their job. For employees in the central agency or corporate office, field and multiple discipline cross-training helps them understand the time requirements for accomplishing field activities. These cross-training opportunities lead to better design and implementation of new programs at the field level.

For the individual employee, cross-training makes them a more valuable asset to their organization and adds variety to their work, which typically results in happier and more productive employees. Cross-training gives the employee an opportunity to build new relationships with other environmental health professionals in their organization, which enhances the team concept for the entire organization. Cross-training does have to be implemented carefully to avoid employee concerns about being replaced or their work not being satisfactory.

Cross-training requires careful planning, upper management support, and engaged employees. The concepts of cross-training should be built into an environmental health organization’s overall training plan with clear expectations and goals. To start, a series of “awareness” type training opportunities covering all program areas in the environmental health organization could be developed and offered to employees.

This training could be augmented with Internet-based training opportunities that are often free and available for a wide variety of environmental health subject areas. Group participation in a webinar followed by a 30-minute facilitated discussion regarding how the topic impacts or is handled by the organization could enhance the value of the training. The use of problem-solving oriented, multidisciplinary training activities, such as tabletop exercises, can also be useful in cross-training. Most sanitarian and environmental health specialist registration programs require continuing education in any of the duties or tasks associated with an environmental health professional, including general environmental health, food, water, wastewater, waste management, hazardous materials, air quality, housing, and occupational safety and health. With this diversity of duties and tasks in mind, continuing education can offer great opportunities to incorporate cross-training.

One major challenge to cross-training is the organizational structure of most environmental health organizations, i.e., organizations that are divided by environmental media or major regulatory areas. Personnel and human relations systems are often not well suited to promote cross-training. Therefore, it requires managers to creatively address ways to allow their environmental health professionals to develop expertise in more than one subject area, such as the use of interdisciplinary workgroups for large projects or regulatory program development or the use of formalized mentoring arrangements among program areas.

When planning your next year’s training calendar or identifying the continuing education to take in the coming year, consider cross-training. It helps increase the overall sustainability and flexibility of environmental health programs and departments. Although it requires consideration, planning, and effort on the part of environmental health organizations and professionals, it is well worth the effort.

Corresponding Author: Nancy Pees Coleman, Principal, Environmental Consultants, 11200 South Miller Avenue, Oklahoma City, OK 73170. E-mail: environconsultants@sbcglobal.net.

Employers increasingly require a professional credential to verify that you are qualified and trained to perform your job duties. Credentials improve the visibility and credibility of our profession, and they can result in raises or promotions for the holder. For 80 years, NEHA has fostered dedication, competency, and capability through professional credentialing. We provide a path to those who want to challenge themselves, and keep learning every day. Earning a credential is a personal commitment to excellence and achievement. Learn more at neha.org/professional-development/credentials.

A credential today can improve all your tomorrows.

A credential today can improve all your tomorrows.
Zika virus, Legionnaires’ disease, and the Flint, Michigan, water crisis are examples of diseases and events requiring a response from a prepared, sufficient, and equipped environmental health workforce. While demands continue to increase, diverse factors such as health department budget cuts and decreased capacity can negatively impact environmental health professionals and programs (Association of State and Territorial Health Officials, 2014; National Association of County and City Health Officials, 2013). These compounding factors reinforce the need to understand the environmental health workforce to identify gaps in staffing, training, and ultimately, to ensure preparedness to meet future challenges. The Centers for Disease Control and Prevention’s (CDC) A National Strategy to Revitalize Environmental Public Health Services, developed with input from numerous environmental health stakeholders representing governmental, nongovernmental, and academic organizations, identified the significance of conducting in-depth evaluations to ensure the existence of a sufficient and well-trained environmental health workforce with the capacity to provide quality services addressing community need (CDC, 2003).

Previous studies describing state, tribal, local, and territorial health departments have addressed aspects of environmental health staffing and services, yet there remains a critical need to engage environmental health professionals with a method designed specifically for the environmental health profession. In response, CDC, the National Environmental Health Association, and Baylor University are partnering on an innovative initiative to characterize the environmental health profession and understand the challenges environmental health professionals encounter. This effort, Understanding the Needs, Challenges, Opportunities, Vision, and Emerging Roles in Environmental Health (UNCOVER EH), presents an unprecedented opportunity to delve into the profession and understand environmental health professional demographics, education and training, experience, areas of practice, and the current and future needs of environmental health professionals.

Though the work of environmental health professionals and the services they deliver are critical to protect local communities, the profession often remains unknown to many until an event occurs and appears on the front page of the newspaper or the nightly news. An initiative like UNCOVER EH has the potential to increase awareness of the profession by obtaining information directly from environmental health professionals about their practice and the challenges they currently face and envision for the future. UNCOVER EH con-

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 these columns, EHSB and guest authors share insights and information about environmental health programs, trends, issues, and resources. The conclusions in this column are those of the author(s) and do not necessarily represent the views of CDC.

LCDR Justin Gerding is an environmental health specialist with CDC’s EHSB. Elizabeth Landeen is the associate director of Program and Partnership Development with the National Environmental Health Association. Bryan Brooks is a distinguished professor of environmental science and biomedical studies and director of environmental health science at Baylor University.
“Workforce evaluations are needed to ascertain the current level of competence, methods of training, effect of training, effect of the ‘essential services’ approach to environmental public health, relations between competencies and practices as they pertain to community-based needs, information that reaches the environmental public health workforce, and effect of workforce-directed activities on the level of competence and job performance.” (p.19)

— A National Strategy to Revitalize Environmental Public Health Services, Centers for Disease Control and Prevention (www.cdc.gov/ncceh/ehs/publications/strategy.htm)

**References**


Efforts are underway to identify and obtain e-mail addresses for environmental health professionals working at health departments across the nation. The identified individuals will receive an e-mail requesting their voluntary participation and will contain a unique web link to access the UNCOVER EH online survey. The survey was designed to collect essential information about the needs of environmental health professionals, professional demographics, education and training, areas of practice, competencies, and the skills and resources necessary to meet evolving and emerging issues and challenges. The survey elements were designed to align with established public health workforce frameworks and assessments (Boulton et al., 2014; Sellers et al., 2015). The survey is expected to take approximately 30 minutes to complete. The information collected will be aggregated for analysis, which prevents linking respondents to their responses.

Following the online survey, several in-person workshops will be held. The workshops will bring together environmental health professionals to review and distill the survey findings and prioritize grand challenges and future needs.

UNCOVER EH will result in a national-level description and analysis of the environmental health profession. The results of this initiative will be made publicly available in a comprehensive report. The report is intended to provide important information for ensuring that the workforce is prepared to address current and future environmental health issues, as well as for shaping the delivery of environmental health services and increasing positive health impacts. UNCOVER EH is scheduled to launch fall 2017 with the release of the online survey. In the meantime, environmental health professionals are encouraged to watch for updates and help increase the awareness of this important initiative. It is crucial to hear from environmental health professionals across the nation to assure generalizable results and broad representation of environmental health challenges, needs, and opportunities. To learn more about UNCOVER EH, please visit www.neha.org/cover-eh.

**Corresponding Author:** Justin A. Gerding, Environmental Health Services Branch, National Center for Environmental Health, Centers for Disease Control and Prevention, 4770 Buford Highway NE, MS F-58, Atlanta, GA 30341. E-mail: JGerding@cdc.gov.
UPCOMING NEHA CONFERENCES


July 8–11, 2019: NEHA 2019 Annual Educational Conference & Exhibition, Nashville, TN.


NEHA AFFILIATE AND REGIONAL LISTINGS

Alabama
October 17–19, 2017: Annual Education Conference, hosted by the Alabama Environmental Health Association, Mobile, AL. For more information, visit www.aeha-online.com.

Colorado

Florida
August 24–27, 2017: Annual Education Meeting, hosted by the Florida Environmental Health Association, Palm Harbor, FL. For more information, visit www.feha.org.

Illinois

Indiana
September 25–27, 2017: Fall Educational Conference, hosted by the Indiana Environmental Health Association, Lawrenceburg, IN. For more information, visit www.iehaind.org.

Jamaica
October 22–26, 2017: International Environmental Conference and IFEH Council Meeting, hosted by the Jamaica Association of Public Health Inspectors in association with the IFEH Americas Region Group member countries, Montego Bay, Jamaica. For more information, contact japhi.ifeh.conference@gmail.com.

Kansas
October 11–13, 2017: Joint Annual Conference and Trade Show, hosted by the Kansas Environmental Health Association and Kansas Small Flows Association, Wichita, KS. For more information, visit www.kehastate.org.

Minnesota
September 19–21, 2017: FDA Central Region Retail Food Protection Seminar and NEHA Region 4 Biannual Educational Conference, Minneapolis, MN. For more information, visit www.mehaonline.org.

New Jersey
September 21, 2017: Annual Symposium, hosted by the New Jersey Environmental Health Association, Edison, NJ. For more information, visit www.njeha.org/events.

North Dakota
October 11–13, 2017: Joint Annual Conference and Trade Show, hosted by the North Dakota Environmental Health Association. For more information, visit html.org/wp/conferences.

Rhode Island

Tennessee
October 4–6, 2017: 71st Annual Interstate Environmental Health Seminar, hosted by the Tennessee Environmental Health Association, Gatlinburg, TN. For more information, visit www.wvdhhr.org/wvas/IEHS/index.asp.

Texas
October 9–13, 2017: Annual Educational Conference, hosted by the Texas Environmental Health Association, Austin, TX. For more information, visit www.myteha.org.

Wisconsin
October 18–20, 2017: Joint Educational Conference, hosted by the Wisconsin Environmental Health Association, Sheboygan, WI. For more information, visit www.weha.net.

The 2017 Integrated Foodborne Outbreak Response and Management (InFORM) Conference, November 6–9, brings together laboratorians, epidemiologists, and environmental health specialists involved with foodborne and enteric disease outbreak response. The online abstract submission form for presentations and posters will be posted on July 3 and will close on July 21. Learn more at www.aphl.org/conferences/InformConf/Pages/2017-Inform-Conference.aspx.
Food Safety Inspector
UL Everclean is a leader in retail inspections. We offer opportunities across the country. We currently have openings for trained professionals to conduct audits in restaurants and grocery stores. Past or current food safety inspection experience is required.

**United States**
- Coeur d’Alene, ID
- Columbus, OH
- Eureka, CA
- Grand Junction, CO
- Grand Rapids, MI
- Honolulu, HI
- Idaho Falls, ID
- Kansas City, MO/KS
- Lexington, KY
- Little Rock, AR
- Louisville, KY
- Lubbock, TX
- Midland, TX
- Odessa, TX
- Owatonna, MN
- Philadelphia, PA
- Rapid City, SD
- Rochester, NY
- San Diego, CA
- Shreveport, LA
- Sioux Falls, SD
- St. Louis, MO
- Syracuse, NY
- Tulsa, OK
- Amarillo, TX
- Bakersfield, CA
- Billings, MT
- Boston, MA
- Buffalo, NY
- Billings, MT
- Coeur d’Alene, ID
- Columbus, OH
- Eureka, CA
- Grand Junction, CO
- Grand Rapids, MI
- Honolulu, HI
- Idaho Falls, ID
- Kansas City, MO/KS
- Lexington, KY
- Little Rock, AR
- Louisville, KY
- Lubbock, TX
- Midland, TX
- Odessa, TX
- Owatonna, MN
- Philadelphia, PA
- Rapid City, SD
- Rochester, NY
- San Diego, CA
- Shreveport, LA
- Sioux Falls, SD
- St. Louis, MO
- Syracuse, NY
- Tulsa, OK
- Wichita, KS
- Yuma, AZ
- Canada
- British Columbia
- Toronto

If you are interested in an opportunity near you, please send your resume to ATTN Sethany Dogra at LST.RAS.RESUMES@UL.COM or visit our Web site at www.evercleanservices.com.

Did You Know?
You can share your event with the environmental health community by posting it directly on our community calendar at www.neha.org/news-events/community-calendar. Averaging 2,000 page views a month, you are sure to bring a lot of attention to your event. Make sure to check it often, and you might find a new event happening in your area!

Compliance Made Easy

**Hot Water Hand Washing**

When you need hot water hand wash compliance for your business you can count on reliable Ozark River Portable Sinks®. Our instant hot water system design is more convenient; more reliable; far more simplified to set-up and operate than our closest competition.

- Indoor and Outdoor
- Environmentally Friendly
- Free Technical Support

Call for a FREE Catalog

1-866-663-1982 OzarkRiver.com

Find a Job
Fill a Job

Where the “best of the best” consult...

**NEHA’s Career Center**

First job listing FREE for city, county, and state health departments with a NEHA member, and for Educational and Sustaining members.

For more information, please visit neha.org/professional-development/careers
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!

Herman Koren and Michael Bisesi (2003)

A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the internal environment. It was written by experts in the field and copublished with the National Environmental Health Association. A variety of environmental issues are covered such as food safety, food technology, insect and rodent control, indoor air quality, hospital environment, home environment, injury control, pesticides, industrial hygiene, instrumentation, and much more. Environmental issues, energy, practical microbiology and chemistry, risk assessment, emerging infectious diseases, laws, toxicology, epidemiology, human physiology, and the effects of the environment on humans are also covered. Study reference for NEHA’s Registered Environmental Health Specialist/Registered Sanitarian credential exam.

790 pages / Hardback
Volume 1: Member: $195 / Nonmember: $215
Two-Volume Set: Member: $349 / Nonmember: $379

Modern Food Microbiology (7th Edition)
James M. Jay, Martin J. Loessner, and David A. Golden (2005)

This text explores the fundamental elements affecting the presence, activity, and control of microorganisms in food. It includes an overview of microorganisms in food and what allows them to grow; specific microorganisms in fresh, fermented, and processed meats, poultry, seafood, dairy products, fruits, vegetables, and other products; methods for finding and measuring microorganisms and their products in foods; methods for preserving foods; food safety and quality controls; and foodborne diseases. Other section topics include biosensors, biocontrol, bottled water, Enterobacter sakazukii, food sanitizers, milk, probiotics, proteobacteria, quorum sensing, and sigma factors. Study reference for NEHA’s Certified Professional–Food Safety credential exam.

790 pages / Hardback
Member: $84 / Nonmember: $89

Herman Koren and Michael Bisesi (2003)

A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the outdoor environment. It was written by experts in the field and copublished with the National Environmental Health Association. A variety of environmental issues are covered such as toxic air pollutants and air quality control; risk assessment; solid and hazardous waste problems and controls; safe drinking water problems and standards; onsite and public sewage problems and control; plumbing hazards; air, water, and solid waste programs; technology transfer; GIS and mapping; bioterrorism and security; disaster emergency health programs; ocean dumping; and much more. Study reference for NEHA’s Registered Environmental Health Specialist/Registered Sanitarian credential exam.

876 pages / Hardback
Volume 2: Member: $195 / Nonmember: $215
Two-Volume Set: Member: $349 / Nonmember: $379

Control of Communicable Diseases Manual (20th Edition)
Edited by David L. Heymann, MD (2015)

The Control of Communicable Diseases Manual (CCDM) is revised and republished every several years to provide the most current information and recommendations for communicable-disease prevention. The CCDM is designed to be an authoritative reference for public health workers in official and voluntary health agencies. The 20th edition sticks to the tried and tested structure of previous editions. Chapters have been updated by international experts. New disease variants have been included and some chapters have been fundamentally reworked. This edition is a timely update to a milestone reference work that ensures the relevance and usefulness to every public health professional around the world. The CCDM is a study reference for NEHA’s Certified Professional–Environmental Health Specialist/Registered Sanitarian and Certified Professional–Food Safety credential exams.

729 pages / Paperback
Member: $59 / Nonmember: $64
A
vailable to those holding an individual NEHA membership only, the JEH Quiz, offered six times per calendar year through the Journal of Environmental Health, is an easily accessible means to accumulate continuing-education (CE) credits toward maintaining your NEHA credentials.

1. Read the featured article carefully.
2. Select the correct answer to each JEH Quiz question.
3. a) Complete the online quiz found at www.neha.org/publications/journal-environmental-health,
b) Fax the quiz to (303) 691-9490, or
c) Mail the completed quiz to JEH Quiz, NEHA 720 S. Colorado Blvd., Suite 1000-N Denver, CO 80246.

Be sure to include your name and membership number!

4. One CE credit will be applied to your account with an effective date of July 1, 2017 (first day of issue).
5. Check your continuing education account online at www.neha.org.
6. You’re on your way to earning CE hours!

Quiz Registration

Name

NEHA Member No.

E-mail

Quiz deadline: October 1, 2017

1. Approximately ___ of foodborne outbreaks caused by Clostridium perfringens occur in correctional facilities.
   a. 5%
   b. 7%
   c. 11%
   d. 15%

2. The following are foods most frequently associated with outbreaks caused by C. perfringens except for
   a. meats.
   b. meat products.
   c. gravy.
   d. vegetables.

3. C. perfringens enterotoxin is inactivated at ___ °F for ___ minutes.
   a. 125; 5
   b. 131; 16.3
   c. 140; 5
   d. 149; 0.9

4. Illness generally is caused when sufficient numbers of C. perfringens are consumed and subsequently produce toxins in the intestines.
   a. True.
   b. False.

5. Of the 185 surveyed individuals who consumed lunch on April 15, 2012, ___ of them were identified as ill according to the case definition.
   a. 29
   b. 58
   c. 76
   d. 108

6. The actual number of sick inmates likely ranged between ___ and ___ based upon a Kent County Correctional Facility estimate and the projection calculated by the survey attack rate, respectively.
   a. 108; 185
   b. 108; 666
   c. 250; 666
   d. 250; 766

7. The mean onset between exposure to the suspected meal and illness was
   a. <1 hour.
   b. 2.5 hours.
   c. 7 hours.
   d. 9 hours.

8. Confirmatory analyses determined that the following contained C. perfringens enterotoxin except for
   a. chicken taco meat mixture.
   b. rice with cheese sauce.
   c. beans.
   d. flour tortillas.

9. The occurrence of ___ and ___ might suggest C. perfringens toxin ingestion.
   a. nausea; vomiting
   b. nausea; fever
   c. fever; diarrhea
   d. vomiting; diarrhea

10. Of the surveyed ill respondents, ___ was the highest indicated symptom.
    a. nausea
    b. abdominal cramps
    c. vomiting
    d. diarrhea

11. The chicken taco meat mixture demonstrated a ___ odds ratio compared to the other menu items.
    a. lower
    b. similar
    c. greater

12. Kent County Health Department concluded that the chicken taco meat mixture was the most probable cause of the foodborne illness outbreak.
    a. True.
    b. False.
<table>
<thead>
<tr>
<th>Code</th>
<th>Corresponding Author/Title</th>
<th>Volume/Issue</th>
<th>Keyword 1</th>
<th>Keyword 2</th>
<th>Keyword 3</th>
<th>Keyword 4</th>
<th>Keyword 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Elizabeth Ablah, MPH, PhD, et al. A Community-Based Participatory Research Approach to Identifying Environmental Concerns</td>
<td>79.5 Dec 2016 Pages: 14–19</td>
<td>Community Nuisances/Safety</td>
<td>Environmental Justice</td>
<td>Hazardous Materials/Toxic Substances</td>
<td>Water Pollution Control/Water Quality</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Jenifer Buckley, PhD Interpersonal Skills in the Practice of Food Safety Inspections: A Study of Compliance Assistance</td>
<td>79.5 Dec 2016 Pages: 8–12</td>
<td>Education/Training</td>
<td>Food</td>
<td></td>
<td>Workforce Development</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Gaurav Dhiman et al. Using Multiple-Antibiotic-Resistance Profiles of Coliforms as a Tool to Investigate Combined Sewer Overflow Contamination</td>
<td>79.3 Oct 2016 Pages: 36–39</td>
<td>Microbiology</td>
<td>Water Pollution Control/Water Quality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Angela Fraser, PhD, et al. Environmental Factors Associated With Norovirus Transmission in Long-Term Care Facilities in South Carolina</td>
<td>79.2 Sept 2016 Pages: 22–29</td>
<td>Emerging Pathogens</td>
<td>Institutions and Schools</td>
<td>Risk Assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Corresponding Author/Title</td>
<td>Volume/Issue</td>
<td>Keyword 1</td>
<td>Keyword 2</td>
<td>Keyword 3</td>
<td>Keyword 4</td>
<td>Keyword 5</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------</td>
<td>--------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>16</td>
<td>Vijay Golla, MPH, PhD, et al.</td>
<td>79.5 Dec 2016 Pages: E1–E6</td>
<td>Drinking Water</td>
<td>Hazardous Materials/Toxic Substances</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Ellen J. Hahn, PhD, RN, FAAN, et al.</td>
<td>79.6 Jan/Feb 2017 Pages: 8–13</td>
<td>Environmental Justice</td>
<td>Indoor Air</td>
<td>Public Health/Safety</td>
<td>Radiation/Radon</td>
<td>Risk Assessment</td>
</tr>
<tr>
<td>18</td>
<td>Heather Henderson, MPH, DVM, et al.</td>
<td>79.7 March 2017 Pages: 16–20</td>
<td>Food</td>
<td>Management/Policy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Zaccheaus Ayo Ibitye, MSc, et al.</td>
<td>79.10 June 2017 Pages: E1–E5</td>
<td>International</td>
<td>Noise</td>
<td>Public Health/Safety</td>
<td>Risk Assessment</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Xu Jie et al.</td>
<td>79.3 Oct 2016 Pages: E1–E8</td>
<td>Epidemiology</td>
<td>Indoor Air</td>
<td>International</td>
<td>Public Health/Safety</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Stephen A. Kells, MS, PhD, BCE, et al.</td>
<td>79.7 March 2017 Pages: 22–27</td>
<td>Community Nuisances/Safety</td>
<td>Education/Training</td>
<td>Environmental Justice</td>
<td>Vector Control</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Jooho Kim, PhD, et al.</td>
<td>79.10 June 2017 Pages: 20–25</td>
<td>Education/Training</td>
<td>Food</td>
<td>Management/Policy</td>
<td>Public Health/Safety</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Brett Koontz, DPA, REHS, et al.</td>
<td>79.4 Nov 2016 Pages: 28–32</td>
<td>Drinking Water</td>
<td>Sustainability</td>
<td>Water Pollution Control/Water Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>James D. Lane, MSc, et al.</td>
<td>79.1 Jul/Aug 2016 Pages: 8–12</td>
<td>Community Nuisances/Safety</td>
<td>International</td>
<td>Noise</td>
<td>Public Health/Safety</td>
<td>Sustainability</td>
</tr>
<tr>
<td>26</td>
<td>Joon-hak Lee, PhD, et al.</td>
<td>79.1 Jul/Aug 2016 Pages: 14–19</td>
<td>Public Health/Safety</td>
<td>Research Methods</td>
<td>Vector Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Yuanan Lu, MS, PhD, et al.</td>
<td>79.7 March 2017 Pages: E1–E9</td>
<td>Ambient Air</td>
<td>Children’s Environmental Health</td>
<td>International</td>
<td>Public Health/Safety</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Jing Ma, PhD, et al.</td>
<td>79.10 June 2017 Pages: 26–31</td>
<td>Education/Training</td>
<td>Food</td>
<td>Management/Policy</td>
<td>Public Health/Safety</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>May A. Massoud et al.</td>
<td>79.8 April 2017 Pages: E1–E7</td>
<td>International</td>
<td>Management/Policy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Corresponding Author/Title</td>
<td>Volume/Issue</td>
<td>Keyword 1</td>
<td>Keyword 2</td>
<td>Keyword 3</td>
<td>Keyword 4</td>
<td>Keyword 5</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>--------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>34</td>
<td>Paschal Nwako, MPH, PhD, REHS, CHES, DAAS The Effect of Inspection Announcement on the Outcome of Food Service Establishment Sanitary Health Evaluations</td>
<td>79.6 Jan/Feb 2017</td>
<td>Food</td>
<td>Management/ Policy</td>
<td>Workforce Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Kelsey J. Pieper, PhD, et al. Simultaneous Influence of Geology and System Design on Drinking Water Quality in Private Systems</td>
<td>79.2 Sept 2016</td>
<td>Drinking Water</td>
<td>Public Health/ Safety</td>
<td>Water Pollution Control/Water Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Stephanie L. Richards, MSEH, PhD, et al. Residual Effectiveness of Permethrin-Treated Clothing for Prevention of Mosquito Bites Under Simulated Conditions</td>
<td>79.8 April 2017</td>
<td>Occupational Health/Safety</td>
<td>Risk Assessment</td>
<td>Vector Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Derek Shendell, MPH, DEnv, et al. Type II Diabetes Emergency Room Visits Associated With Hurricane Sandy in New Jersey: Implications for Preparedness</td>
<td>79.2 Sept 2016</td>
<td>Disaster/ Emergency Response</td>
<td>Epidemiology</td>
<td>Management/ Policy</td>
<td>Risk Assessment</td>
<td>Terrorism/ All-Hazards Preparedness</td>
</tr>
</tbody>
</table>
### Corresponding Author and Subject Index

**Journal of Environmental Health**

*Volume 79: July/August 2016–June 2017*

<table>
<thead>
<tr>
<th>Code</th>
<th>Corresponding Author/Title</th>
<th>Volume/Issue</th>
<th>Keyword 1</th>
<th>Keyword 2</th>
<th>Keyword 3</th>
<th>Keyword 4</th>
<th>Keyword 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Mitsuo Uchida, MD, PhD, et al. Association Between Keeping Pet Animals and Allergic Rhinitis: A Case-Control Study Among Japanese University Students</td>
<td>79.4 Nov 2016 Pages: E1–E8</td>
<td>Epidemiology</td>
<td>Indoor Air</td>
<td>Institutions and Schools</td>
<td>International</td>
<td>Risk Assessment</td>
</tr>
<tr>
<td>46</td>
<td>Wendy C. Varnado, PhD, et al. Use of the VectorTest for Advanced Warning of Human West Nile Virus Cases in Mississippi</td>
<td>79.5 Dec 2016 Pages: 20–24</td>
<td>Management/Policy</td>
<td>Vector Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>Caitlin Weems, MS, et al. Reframing Climate Change for Environmental Health</td>
<td>79.8 April 2017 Pages: 24–27</td>
<td>Meteorology/Weather/Climate</td>
<td>Sustainability</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Subject Corresponding Author/Title Code

<table>
<thead>
<tr>
<th>Subject</th>
<th>Corresponding Author/Title Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Air</td>
<td>27</td>
</tr>
<tr>
<td>Children’s Environmental Health</td>
<td>27, 32, 37</td>
</tr>
<tr>
<td>Community Nuisances/Safety</td>
<td>1, 21, 24, 25</td>
</tr>
<tr>
<td>Disaster/Emergency Response</td>
<td>3, 42</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>15, 16, 23, 36, 41</td>
</tr>
<tr>
<td>Education/Training</td>
<td>5, 21, 22, 28, 30, 32</td>
</tr>
<tr>
<td>Emerging Pathogens</td>
<td>12</td>
</tr>
<tr>
<td>Environmental Justice</td>
<td>1, 15, 17, 21</td>
</tr>
<tr>
<td>Epidemiology</td>
<td>8, 9, 11, 20, 42, 45</td>
</tr>
<tr>
<td>Food</td>
<td>5, 6, 18, 22, 28, 31, 34</td>
</tr>
<tr>
<td>Hazardous Materials/Toxic Substances</td>
<td>1, 7, 9, 14, 16, 25, 33, 35, 38, 43</td>
</tr>
<tr>
<td>Indoor Air</td>
<td>17, 20, 30, 37, 45</td>
</tr>
<tr>
<td>Institutions and Schools</td>
<td>3, 12, 32, 37, 45</td>
</tr>
<tr>
<td>International</td>
<td>3, 14, 19, 20, 24, 27, 29, 37, 45</td>
</tr>
<tr>
<td>Lead</td>
<td>7, 25, 44</td>
</tr>
<tr>
<td>Management/Policy</td>
<td>3, 7, 13, 18, 22, 28, 29, 32, 34, 40, 41, 42, 46</td>
</tr>
<tr>
<td>Media/Reporting</td>
<td>6</td>
</tr>
<tr>
<td>Meteorology/Weather/Climate</td>
<td>3, 43, 47</td>
</tr>
<tr>
<td>Microbiology</td>
<td>10</td>
</tr>
<tr>
<td>Noise</td>
<td>2, 19, 24</td>
</tr>
<tr>
<td>Occupational Health/Safety</td>
<td>2, 33, 35, 38, 39</td>
</tr>
<tr>
<td>Pools/Spas</td>
<td>8, 11</td>
</tr>
<tr>
<td>Public Health/Safety</td>
<td>4, 6, 9, 13, 17, 19, 20, 22, 24, 26, 27, 28, 30, 32, 36, 41</td>
</tr>
<tr>
<td>Radiation/Radon</td>
<td>17</td>
</tr>
<tr>
<td>Recreational Environmental Health</td>
<td>2, 8, 11</td>
</tr>
<tr>
<td>Research Methods</td>
<td>4, 9, 26</td>
</tr>
<tr>
<td>Risk Assessment</td>
<td>12, 14, 17, 19, 31, 39, 42, 45</td>
</tr>
<tr>
<td>Solid Waste</td>
<td>7</td>
</tr>
<tr>
<td>Sustainability</td>
<td>23, 24, 43, 47</td>
</tr>
<tr>
<td>Technology</td>
<td>7, 13, 25, 44</td>
</tr>
<tr>
<td>Terrorism/All-Hazards Preparedness</td>
<td>42</td>
</tr>
<tr>
<td>Vector Control</td>
<td>21, 26, 39, 40, 46</td>
</tr>
<tr>
<td>Wastewater</td>
<td>14</td>
</tr>
<tr>
<td>Water Pollution Control/Water Quality</td>
<td>1, 10, 11, 14, 15, 23, 36, 41, 43</td>
</tr>
<tr>
<td>Workforce Development</td>
<td>5, 13, 34</td>
</tr>
</tbody>
</table>
SAVE THE DATE
Annual Educational Conference
NEHA 2018 AEC • neha.org/aec
Anaheim  •  California  •  June 25-28, 2018
National Environmental Health Association

NEHA ORGANIZATIONAL MEMBERS

Sustaining Members
Accela
www.acela.com
Advanced Fresh Concepts Corp.
www.afcsushi.com
Air Chek, Inc.
www.radon.com
Albuquerque Environmental Health Department
www.cabq.gov/environmentalhealth
Allegheny County Health Department
www.achd.net
American Chemistry Council
www.americanchemistry.com
Arlington County Public Health Division
www.arlingtonva.us
Association of Environmental Health Academic Programs
www.eaeap.org
Cabell-Huntington Health Department
www.cabellhealth.org
Chemstar Corporation
www.chemstarcorp.com
Chester County Health Department
www.cheesco.org/health
City of St. Louis Department of Health
www.stlouis-mo.gov/government/departments/health
Colorado Department of Public Health and Environment, Division of Environmental Health and Sustainability, DPU
www.colorado.gov/cdphe
Denver Department of Environmental Health
www.denvergov.org/DEH
Digital Health Department, Inc.
www.dhdinspections.com
DuPage County Health Department
www.dupagehealth.org
Ecobond Lead Defender
www.ecobondlbp.com
Ecolab
www.ecolab.com
EcoSure
adolfo.rosales@ecolab.com
Eljen Corporation
www.eljen.com
Erie County Department of Health
www.erie.gov/health
Gila River Indian Community: Environmental Health Service
www.gilariver.org
GLO GERM/Food Safety First
www.glogerm.com
Gojo Industries
www.gojo.com
Health Department of Northwest Michigan
www.nwhealth.org
HealthSpace USA Inc
www.healthspace.com
Hedgerow Software Ltd.
www.hedgerowsoftware.com
Hoot Systems, LLC
http://hootsystems.com
Industrial Test Systems, Inc.
www.sensafe.com
Jackson County Environmental Health
www.jacksongov.org/422/Environmental-Health-Division
Jefferson County Public Health (Colorado)
http://jelfco.us/public-health
Kanawha-Charleston Health Department
http://kchdwv.org
Kenosha County Division of Health
www.co.kenosha.wi.us/297/Health-Services
LaMotte Company
www.lamotte.com
Lenawee County Health Department
www.lenaweehealthdepartment.org
Maricopa County Environmental Services
www.maricopa.gov/631/Environmental-Services
Muninomah County Environmental Health
https://mulco.us/health
Nashua Department of Health
http://nashanh.gov/497/Public-Health-Community-Services
National Environmental Health Science and Protection Accreditation Council
www.ehacoffice.org
New Mexico Environment Department
www.env.nm.gov
New York City Department of Health & Mental Hygiene
www.nyc.gov/health
NSF International
www.nsf.org
Omaha Healthy Kids Alliance
http://omahahealthykids.org
Opportunity Council/Building Performance Center
www.buildingperformancecenter.org
Otter Tail County Public Health
www.co.ottertail.mn.us/494/Public-Health
Paster Training, Inc.
www.pastertraining.com
Polk County Public Works
www.polkcountyiowa.gov/publicworks
QuanTEM Food Safety Laboratories
www.quantemfood.com
Seattle & King County Public Health
www.kingcounty.gov/healthservices/health.aspx
Seminole Tribe of Florida
www.semtribe.com
Sonoma County Permit and Resource Management Department, Well and Septic Division
www.sonomacounty.org/prmd/divpages/wellsediv.htm
Southwest District Health Department
www.swdh.org
Starbucks Coffee Company
www.starbucks.com
StateFoodSafety.com
www.statefoodsafety.com
Stater Brothers Market
www.staterbrothers.com
Steritech Group, Inc.
www.steritech.com
Sweeps Software, Inc.
www.sweepssoftware.com
Texas Roadhouse
www.texaroadhouse.com
The University of Findlay
www.findlay.edu
Tri-County Health Department
www.tchd.org
UL
www.ul.com
Waco-McLennan County Public Health District
www.waco-texas.com/cms-healthdepartment
Waukesha County Environmental Health Division
www.waukeshacounty.gov/environmental_health
Wegmans Food & Pharmacy, Inc.
www.wegmans.com
Winn-Dixie Stores
www.winn-dixie.com

Educational Members
Baylor University
www.baylor.edu
East Tennessee State University, Department of Environmental Health
www.etsu.edu
Illinois State University, Environmental Health Program
www.ilstu.edu
Michigan State University Extension
www.msue.anr.msu.edu
Michigan State University, Online Master of Science in Food Safety
www.online.foodsafety.msu.edu
University of Washington, Department of Environmental & Occupational Health Sciences
www.deohs.washington.edu
University of Wisconsin–Oshkosh, Lifelong Learning & Community Engagement
www.uwosh.edu/llice
University of Wisconsin–Stout, College of Science, Technology, Engineering, and Mathematics
www.uwstout.edu
The board of directors includes NEHA's nationally elected officers and regional vice-presidents. Affiliate presidents (or appointed representatives) comprise the Affiliate Presidents Council. Technical advisors, the executive director, and all past presidents of the association are ex-officio council members. This list is current as of press time.

**National Officers**

President—Adam London, MPA, RS, DAAS, Health Officer, Kent County Health Department, Grand Rapids, MI. adamlondon@gmail.com

President-Elect—Vince Radke, MPH, RS, CP-FS, DAAS, CPH, Environmental Health Specialist, Atlanta, GA. vradke@bellsouth.net

First Vice-President—Priscilla Oliver, PhD, Life Scientist, U.S. EPA, Atlanta, GA. POliverMSM@aol.com

Second Vice-President—Sandra Long, MS, REHS, RS, Longview, WA. davidriggs@comcast.net

Immediate Past-President—David E. Riggs, PhD, Immediate Past-President. 

**Regional Vice-Presidents**

Region 1—Matthew Reighter, MPH, REHS, CP-FS, Retail Quality Assurance Manager, Starbucks Coffee Company, Seattle, WA. mreighte@starbucks.com

Region 2—Keith Allen, MPA, REHS, DAAS, Director, City of Plano Health Department, Plano, TX. kallenrehs@yahoo.com

Region 3—Roy Kroeger, REHS, City of Laramie Health Department, Cheyenne, WY. kramdin@salem.com

Region 4—Sharon Smith, REHS/RS, Sanitarian Supervisor, Minnesota Department of Health, Underwood, MN. sharon.smith@state.mn.us

Region 5—Tom Vyles, REHS/RS, CP-FS, Environmental Health Manager, Town of Flower Mound, TX. tvyles@flower-mound.com

Region 6—Lynne Madison, RS, Environmental Health Division Director, Western UP Health Department, Hancock, MI. lmadison@flume.org

Region 7—Timothy Mitchell, REHS, CP-FS, CQA Technical Coordinator, Publix Super Markets, Inc., Lakeland, FL. tim.mitchell@publix.com

Region 8—LCDR James Speakhart, MS, USPHS, Health and Safety Officer, FDA, CDRH-Health and Safety Office, Silver Spring, MD. jamesmspeakhart@gmail.com

Region 9—Larry Ramdin, REHS, CP-FS, HHS, Health Agent, Salem Board of Health, Salem, MA. lramdin@salem.com

Region 10—Patty Nociek, REHS/RS, CP-FS, La Porte County Health Dept., La Porte, IN. pmnociek@laporte county.org

Region 11—Michelle Claussen Rosenfeld, MPH, REHS, Director of Environmental Health, Siouxland District Health Dept., Sioux City, IA. mcclusen@sioux-city.org

Region 12—Rowan Stephens, St. Catherine, Jamaica. info@paphl.org jm

Region 13—Guy Crabill, Lawrence, KS. gcrabill@franklincoks.org

Region 14—Don Jacobs, Three River District Health Dept., Fullmouth, KY. donalde.jacobs@ky.gov

Region 15—Bill Schramm, Louisiana Dept. of Environmental Quality, Baton Rouge, LA. bill.schramm@louisiana.gov

Region 16—James Lewis, Westminster, MD. jlewos@nude.state.md.us

Region 17—Jeff Jackson, Camden, AR. jeff.jackson@arkansas.gov

Region 18—Judy Eggleton, U.S. EPA, Washington, DC. je@epa.gov

Region 19—Timothy Mitchell, REHS, CP-FS, Retail Quality Assurance Manager, Starbucks, Denver, CO. swalling@starbucks.com

**Affiliate Presidents**

Alabama—Stacy Williamson, MSM, REHS, Public Health Environmental Supervisor, Covington County Health Dept., Red Level, AL. president@uecha-online.com

Alaska—John Walker, Soldotna, AK. john@jakfoodsafty.com

Arizona—Steve Willie, Maricopa County Environmental Services Dept., Phoenix, AZ. swille@mail.maricopa.gov

Arkansas—Jeff Jackson, Camden, AR. jeff.jackson@arkansas.gov

Business & Industry—Shelly Wallingford, MS, REHS, Retail Quality Assurance Manager, Starbucks, Denver, CO. swalling@starbucks.com

California—Ric Encarnacion, REHS, MPH, Assistant Director, County of Monterey Environmental Health Bureau, Salinas, CA. Encarnacion@co.monterey.ca.us

Colorado—Tom Butts, MSc, REHS, Deputy Director, Tri-County Health Dept., Greenwood Village, CO. tbuts@tchd.org

Connecticut—Matthew Payne, REHS/RS, HHS, Environmental Health Inspector, Town of Manchester, Colchester, CT. mmpayne24@gmail.com

Florida—Michael Crea, Sarasota, FL. creaml@gmail.com

Hawaii—John Nakashima, Sanitarian IV, Food Safety Education Program, Hawaii Dept. of Health, Hilo, HI. john.nakashima@doj.hawaii.gov

Idaho—Tyler Fortunati, Idaho Dept. of Environmental Quality, Meridian, ID. tyler.fortunati@deq.idaho.gov

Illinois—David Banaszynski, Environmental Health Officer, Hoffman Estates, IL. davidbh@hoffmanestates.org

Indiana—Patty Nociek, REHS/RS, CP-FS, La Porte County Health Dept., La Porte, IN. pmnociek@laporte county.org

Iowa—Michelle Claussen Rosenfeld, MPH, REHS, Director of Environmental Health, Siouxland District Health Dept., Sioux City, IA. mcclusen@sioux-city.org

Jamaica—Rowan Stephens, St. Catherine, Jamaica. info@paphl.org jm

Kanasa—Guy Crabill, Lawrence, KS. gcrabill@franklincoks.org

Kentucky—Don Jacobs, Three River District Health Dept., Fullmouth, KY. donalde.jacobs@ky.gov

Louisiana—Bill Schramm, Louisiana Dept. of Environmental Quality, Baton Rouge, LA. bill.schramm@louisiana.gov

Maryland—James Lewis, Westminster, MD. jlewos@nude.state.md.us

Massachusetts—Leon Bethune, Director, Boston Public Health Commission, West Roxbury, MA. bethleon@aol.com

Michigan—Sara Simmonds, MPA, REHS/RS, Grand Rapids, MI. ssimmonds@mea.net

Minnesota—Nicole Hedeen, Epidemiologist, Minnesota Dept. of Health, White Bear Lake, MN. nicole.hedeen@state.mn.us

Mississippi—Susan Bates, Mississippi Dept. of Health/Webster County Health Dept., Pheba, MS. susan.bates@msdh.state.ms.us

Missouri—Kristi Ressel, KCMO Health Dept., Kansas City, MO. kristiressel@gmail.com

Missouri Milk, Food, and Environmental Health Association— Roxanne Sharp, Public Health Investigator II, Springfield/Greene County Health Dept., Springfield, MO. rsharp@springfieldmo.gov

Montana—Alisha Johnson, Missoula County Health Dept. Missoula, MT. alishaerikajohnson@gmail.com

National Capital Area—Kristen Pybus, MPA, REHS/RS, CP-FS, Fairfax County Health Dept., VA. kpubus@ncacha.com

Nebraska—Ericka Sanders, Nebraska Dept. of Agriculture, O’Neill, NE. ericka.sanders@nebraska.gov

Nevada—Erin Cavin, REHS, Environmental Health Specialist II, Southern Nevada Health District, Las Vegas, NV. nevadachds@gmail.com

New Jersey—Paschal Nwako, MPH, PhD, CHES, DAAS, Health Officer, Camden County Health Dept., Blackwood, NJ. pn28@njms.net

New Mexico—Cecilia Garcia, MS, CP-FS, Environmental Health Specialist, City of Albuquerque Environmental Health Dept., Albuquerque, NM. gcargas@cabq.gov

New York—Contact Region 9 Vice-President Larry Ramdin. lramdin@salem.com

North Carolina—Stacey Robbins, Brevard, NC. stacey.robbins@transylvania county.org

North Dakota—Grant Larson, Fargo Cass Public Health, Fargo, ND. glarson@cityoffargo.com

Northern New England Environmental Health Association—Brian Lockard, Health Officer, Town of Salem Health Dept., Salem, NH. blockard@ci.salem.nh.us
Ohio—Chad Brown, RS, REHS, MPH, Licking County Health Dept., Newark, OH. cbrown@lickingcohealth.org

Oklahoma—James Splawn, RPS, RPES, Sanitarian, Tulsa City-County Health Dept., Tulsa, OK. tsplawn@tulsa-health.org

Oregon—William Emminger, REHS/RS, Corvallis, OR. bill.emminger@co.benton.or.us

Past President—Bob Custard, REHS, CP-FS, Lovettsville, VA. BobCustard@comcast.net

Rhode Island—Dottie LeBeau, CP-FS, Food Safety Consultant and Educator, Rhode Island—Dottie LeBeau, CP-FS, BobCustard@comcast.net

South Dakota—John Osburn, Pierre, SD. john.osburn@state.sd.us

Tennessee—Eric L. Coffey, Chattanooga, TN. techapresident@gmail.com

Texas—Victor Baldovinos, Environmental Health Director, City of South Padre Island, TX. vbaldovinos@myspi.org

Uniformed Services—CDR Katherine Hubbard, MPH, REHS, Senior Institutional Environmental Health Consultant, Alaska Native Tribal Health Consortium, Anchorage, AK. knhubbard@anths.org

Utah—Phil Bondurant, MPH, Director of Environmental Health, Summit County Health Dept., Heber City, NV. pbondurant@summitcounty.org

Virginia—David Friderich, Environmental Health Supervisor, Virginia Dept. of Health, Lancaster, VA. david.friderich@virginia.gov

Washington—Michael Baker, MS, PhD, Dept. of Environmental Health Director, Whitman County Public Health, Pullman, WA. michael.baker@whitmancounty.net

West Virginia—Brad Cochran, Charleston, WV. brad.j.cochran@wv.gov

Wisconsin—Sonja Dimitrijevic, Dept. of Agriculture, Trade, and Consumer Protection, WI. sonja.dimitrijevic@wisconsin.gov

Wyoming—Tiffany Gaertner, REHS, CP-FS, EHS II, Cheyenne-Laramie County Health Dept., Cheyenne, WY. tgaertner@laramiecounty.com

Technical Advisors

Air Quality—Vacant

Aquatic Health/Recreational Health—Tracynda Davis, MPH, Davis Strategic Consulting, LLC. tracynda@yahoo.com

Aquatic Health/Recreational Health—CDR Jason Kunz, MPH, REHS, USPHS, CDC/NCEH. izsk@cdc.gov

Children’s Environmental Health—Anna Jeng, MS, ScD, Old Dominion University hjeng@odu.edu

Climate Change—Leon Vinci, DHA, RS. live@uom.com

Drinking Water/Environmental Water Quality—Craig Gilbertson, Minnesota Dept. of Health. craig.gilbertson@state.mn.us

Emergency Preparedness and Response—Marcy Barnett, MA, MS, REHS, California Dept. of Public Health, Center for Environmental Health. marcy.barnett@cdph.ca.gov

Emergency Preparedness and Response—Martin Kalis, CDC. mkalis@cdc.gov

Food (including Safety and Defense)—Eric Bradley, MPH, REHS, CP-FS, DAAS, Scott County Health Dept. eric.bradley@scottcountyiowa.com

Food (including Safety and Defense)—John Marcello, CP-FS, REHS, FDA. john.marcello@fda.hhs.gov

General Environmental Health—Tara Gorge, Needham Health Dept. tgorge@needham.ma.gov

General Environmental Health—MI Tanner, IHHS. mtanner@ihrs.com

Hazardous Materials/Toxic Substances—Crispin Pierce, PhD, University of Wisconsin-Eau Claire. piercech@uwec.edu

Healthy Communities/Built Environment—Kari Sasportas, MSW, MPH, REHS/RS, Cambridge Public Health Dept. ksasportas@challiance.org

Healthy Homes and Housing—Judeith Luong, City of Long Beach Health Dept. juluong@longbeach.gov

Industry—Nicole Grisham, University of Colorado. nicole.grisham@colorado.edu

Informatics and Technology—Darryl Booth, MPA, Accela. dbbooth@acela.com

Injury Prevention—Alan Della-penna, RS, North Carolina Division of Public Health. alan.dellapenna@dhhs.nc.gov

Institutions—Robert W. Powitz, MPH, PhD, RS, CP-FS, R.W. Powitz & Associates, PC. powitz@sanitarium.com

International Environmental Health—Sylvanus Thompson, MPH, CPRH(C), Toronto Public Health. sphmpo@toronto.ca

Land Use Planning and Design—Robert Washam, MPH, RS. hwasham@hotmail.com

Ocational Health/Safety—Tracy Zentek, PhD, Western Carolina University. zentekc@email.wcu.edu

Onsite Wastewater—Joeelle Wirth, RS, Environmental Quality Division, Coconino County Health Dept. jwirth@coconino.az.gov

Onsite Wastewater—Denise Wright, Indiana State Dept. of Health. dlwright@isdh.in.gov

Radiation/Radon—Bob Uhirk, South Brunswick Township. ruhrbk@bnj.net

Risk Assessment—Jason Marion, PhD, Eastern Kentucky University. jason.marion@eku.edu

Schools—Stephan Buckman, Worthington City Schools. mphpso@yahoo.com

Sustainability—Tim Murphy, PhD, REHS/RS, DAAS, The University of Findlay. murphy@findlay.edu

Vector Control/Zoonotic Disease Control—Steven Ault, PAHO/WHO (retired). aultster@hotmail.com

Vector Control/Zoonotic Disease Control—Zia Siddiqi, PhD, BCE, Orkin/Rollins Pest Control. zsiddiq@rollins.com

Workforce Development, Management, and Leadership—George Nakamura, MPH, REHS, RS, CP-FS, DAAS, Nakamura Leasing. gmlnaka@comcast.net

NEHA Staff: (303) 756-9090

Seth Arends, Graphic Artist, NEHA, Entrepreneurial Zone (EZ), ext. 318, sarend@neha.org

Jonna Ashley, Association Membership Manager, ext. 336, jashey@neha.org

Rancer Baker, Program Administrator, NEHA EZ, ext. 300, rbaker@neha.org

Trisha Bramwell, Sales and Training Support, NEHA EZ, ext. 340, tbramwell@neha.org

Vanessa DeArman, Program Coordinator, Program and Partnership Development (PPD), ext. 311, vdearman@neha.org

Kristie Denbrock, Education Coordinator, ext. 313, kdienbrock@neha.org

David Dyjack, Executive Director, ext. 301, ddyljack@neha.org

Santiago Ecurra, Media Production Specialist, NEHA EZ, ext. 342, securra@neha.org

Eric File, Learning Media Manager, NEHA EZ, ext. 344, efile@neha.org

Soni Fink, Strategic Sales Coordinator, ext. 314, sfink@neha.org

Nancy Finney, Technical Editor, NEHA EZ, ext. 326, nfinney@neha.org

Michael Gallagher, Operations and Logistics Planner, NEHA EZ, ext. 343, mgallagher@neha.org

TJay Gerber, Credentialing Coordinator, ext. 328, tgerber@neha.org

Arwa Hurley, Website and Digital Media Specialist, ext. 327, ahurley@neha.org

Faye Koelzow, Business Analyst, ext. 302, fkoelzow@neha.org

Elizabeth Landeen, Associate Director, PPD, (702) 802-3924, elandeen@neha.org

Matt Lieder, Database Administrator, ext. 325, mlieder@neha.org

Bobby Medina, Credentialing Dept. Customer Service Coordinator, ext. 310, bmedina@neha.org

Marissa Miles, Human Resources Manager, ext. 304, mmiles@neha.org

Eileen Neison, Credentialing Specialist, ext. 339, eneison@neha.org

Carol Newlin, Credentialing Specialist, ext. 337, cnnewlin@neha.org

Solly Poprish, CDC Public Health Associate Program Intern, ext. 335, sopprish@neha.org

Barry Porter, Financial Coordinator, ext. 308, bporter@neha.org

Kristen Ruby-Cisneros, Managing Editor, Journal of Environmental Health, ext. 341, kruby@neha.org

Rachel Saasuer, Member Services/Accounts Receivable, ext. 300, rsaasuer@neha.org

Chrisil Tate, Program Manager, PPD, ext. 303, ctate@neha.org

Sharon Unkart, Instructional Designer, NEHA EZ, ext. 317, sduenkart@neha.org

Gail Vail, Director, Finance, ext. 309, gvail@neha.org

Sandra Whitehead, Director, PPD, ext. 309, swhitehead@neha.org

Rachel Zurcher, Director, Government Affairs, jzurcher@neha.org

Joanne Zurcher, Director, Government Affairs, jzurcher@neha.org

July/August 2017 • Journal of Environmental Health
The Journal of Environmental Health thanks and honors the individuals listed below whose contributions as peer reviewers are paramount to the Journal’s efforts to advance, educate, and promote the science and profession of environmental health. We sincerely appreciate their hard work, devotion to the environmental health profession, and willingness to share their wealth of knowledge and expertise.

Becky Nancy Achieng Aloo, MSc  
Eldoret, Kenya

Anna Marie Aragon, MSIR, MAEd, CPS, ASP, REHS  
APO, AE

Sushrut Arora, MVSc, PhD  
Houston, TX

Gholamreza Asadollahfardi, MS, PhD  
Tehran, Iran

Anna Marie Aragon, MSIR, MAEd, CPS, ASP, REHS  
APO, AE

Sushrut Arora, MVSc, PhD  
Houston, TX

Gholamreza Asadollahfardi, MS, PhD  
Tehran, Iran

Erik Balster, MPH, REHS, RS  
Eaton, OH

David Banaszynski, REHS, CP-FS  
Hoffman Estates, IL

Brad H. Baugh, PhD, RN, REHS/RS, RPIH  
Nine Mile Falls, WA

Alan Becker, MPH, PhD  
Tallahassee, FL

C. Thomas Bell, PhD, RS  
Lubbock, TX

Mitchell Berger, MPH  
Exton, PA

Dean Bodager, MPA, RS, DAAS  
Orlando, FL

Craig Bowe, PhD  
Freeport, Bahamas

Eric Bradley, MPH, REHS, CP-FS, DAAS  
Davenport, IL

Freda W. Bredy, REHS, PMP  
Alexandria, VA

David Breeding, PhD, RS, CSP  
College Station, TX

Matthew C. Brim, MS  
Belton, TX

Gary Brown, DrPH, CIH, RS  
Durham, NH

Rosemary M. Caron, MPH, PhD  
Durham, NH

Byron D. Chaves-Elizondo, MS  
Lubbock, TX

Jiangang Chen, PhD  
Knoxville, TN

Valerie M. Cohen, MPH, REHS  
Las Vegas, NV

James Couch, MS, CIH, CSP, REHS/RS  
Cincinnati, OH

Chris J. Coutts, MPH, PhD  
Tallahassee, FL

CDR Miguel Cruz, MPH  
Atlanta, GA

Paulomi Das, MSc, PhD  
Kalyani, India

Tracynda Davis, MPH  
Colorado Springs, CO

Royal DeLegge, PhD, LEHS, RS  
Murray, UT

James D. Dingman, MS, REHS, DLAAS  
Plano, TX

Maria Alzira Primenta Dinis, PhD  
Porto, Portugal

Zachary Ehrlich, MS, REHS  
West Orange, NJ

Robert Emery, DrPH, CHP, CIH, CSP, RBP, CHMM, CPP, ARM  
Houston, TX

Major Jason Finley, MS, DAAS, REHS, RS, CHMM  
Louisville, KY

Thomas R. Gonzales, MPH, REHS  
Colorado Springs, CO

Patrick Goodman, PhD  
Dublin, Ireland

Harry E. Grenawitzke, Jr., MPH, RS, DAAS  
Monroe, MI

Matthew Griible  
Baltimore, MD

Yi Guo, MSPH, PhD  
Gainesville, FL

John J. Guzewich, MPH, RS  
Albany, NY

Eric S. Hall, MA, MCE  
Durham, NC

Daikwon Han, PhD  
College Station, TX

Xuesong Han, PhD  
Atlanta, GA

Justin E. Harbison, PhD  
Maywood, IL

Francis Charles Hart, PhD, CIH, CSP, RS  
Kenton, OH

Muhammad Zaffar Hashmi, MSc, MPhl, PhD  
Islamabad, Pakistan

Jerry Hatch, CP-FS, CEHT, BCE  
St. Petersburg, FL

Timothy N. Hatch, MPH, REHS  
Montgomery, AL

Michelle Homan, PhD  
Erie, PA
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>City, State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Joseph J. Hout, PhD, CIH, CSP, REHS, DAAS</td>
<td>Lytle, TX</td>
<td></td>
</tr>
<tr>
<td>Jin Huang, PhD</td>
<td>Athens, OH</td>
<td></td>
</tr>
<tr>
<td>Li Huang, PhD</td>
<td>Albany, NY</td>
<td></td>
</tr>
<tr>
<td>Elizabeth Irvin-Barnwell, PhD</td>
<td>Atlanta, GA</td>
<td></td>
</tr>
<tr>
<td>James D. Johnston, PhD, CIH</td>
<td>Provo, UT</td>
<td></td>
</tr>
<tr>
<td>Kimball E. Jones, MSPH, RS-E</td>
<td>Lake Forest Park, WA</td>
<td></td>
</tr>
<tr>
<td>Misty Joy, MPH, REHS</td>
<td>Cumberland, MD</td>
<td></td>
</tr>
<tr>
<td>Gregory D. Kearney, MPH, DrPH, RS</td>
<td>Greenville, NC</td>
<td></td>
</tr>
<tr>
<td>Igor Koturbash, PhD, MD</td>
<td>Little Rock, AR</td>
<td></td>
</tr>
<tr>
<td>Keith L. Krinn, MA, RS, DAAS, CPHA</td>
<td>Columbus, OH</td>
<td></td>
</tr>
<tr>
<td>Sharron LaFollette, PhD</td>
<td>Springfield, IL</td>
<td></td>
</tr>
<tr>
<td>John Lange</td>
<td>Pittsburgh, PA</td>
<td></td>
</tr>
<tr>
<td>Madeleine LaRue</td>
<td>Chapel Hill, NC</td>
<td></td>
</tr>
<tr>
<td>Grace Lasker, PhD, CN</td>
<td>Kirkland, WA</td>
<td></td>
</tr>
<tr>
<td>Scott T. LeRoy, MPH, MS, REHS/RS</td>
<td>New Milford, CT</td>
<td></td>
</tr>
<tr>
<td>Courtney D. Lewis, MS</td>
<td>Odessa, TX</td>
<td></td>
</tr>
<tr>
<td>Dingsheng Li</td>
<td>Ann Arbor, MI</td>
<td></td>
</tr>
<tr>
<td>Zhanbei Liang, PhD</td>
<td>Ada, OK</td>
<td></td>
</tr>
<tr>
<td>Chuck Lichon, MPH, RS</td>
<td>Linwood, MI</td>
<td></td>
</tr>
<tr>
<td>Maureen Y. Lichtveld, MPH, MD</td>
<td>New Orleans, LA</td>
<td></td>
</tr>
<tr>
<td>Xuyang Liu, PhD</td>
<td>St. Louis, MO</td>
<td></td>
</tr>
<tr>
<td>Ting Lu, PhD</td>
<td>Cincinnati, OH</td>
<td></td>
</tr>
<tr>
<td>Yuan Lu, PhD</td>
<td>Houston, TX</td>
<td></td>
</tr>
<tr>
<td>Ming Luo, PhD</td>
<td>Rensselaer, NY</td>
<td></td>
</tr>
<tr>
<td>Lois Maisel, RN, CP-FS</td>
<td>Madison, WI</td>
<td></td>
</tr>
<tr>
<td>Ephraim Massawe, PhD</td>
<td>Hammond, LA</td>
<td></td>
</tr>
<tr>
<td>Ruth McDermott-Levy, MPH, PhD</td>
<td>Villanova, PA</td>
<td></td>
</tr>
<tr>
<td>Edward Mc Keown, MS, PhD</td>
<td>Flagstaff, AZ</td>
<td></td>
</tr>
<tr>
<td>Stuart Mitchell, MPH, PhD, BCE</td>
<td>Des Moines, IA</td>
<td></td>
</tr>
<tr>
<td>G. Poya Moli, PhD</td>
<td>Puducherry, India</td>
<td></td>
</tr>
<tr>
<td>Michele M. Monti, MS, MPH</td>
<td>Atlanta, GA</td>
<td></td>
</tr>
<tr>
<td>Vinayak K. Nahar, MS, MD</td>
<td>Oxford, MS</td>
<td></td>
</tr>
<tr>
<td>Asia Neelam, MSc</td>
<td>Karachi, Pakistan</td>
<td></td>
</tr>
<tr>
<td>Priscilla Oliver, MPA, PhD</td>
<td>Atlanta, GA</td>
<td></td>
</tr>
<tr>
<td>LCDR Stephen M. Perrine, MS, REHS/RS, CP-FS</td>
<td>Washington, DC</td>
<td></td>
</tr>
<tr>
<td>Eric Pessell, REHS</td>
<td>Grand Rapids, Mi</td>
<td></td>
</tr>
<tr>
<td>David S. Peterson, MBA, MPA, RS, DAAS</td>
<td>Edmonds, WA</td>
<td></td>
</tr>
<tr>
<td>Robert W. Powitz, MPH, PhD, RS, DLAAS</td>
<td>Old Saybrok, CT</td>
<td></td>
</tr>
<tr>
<td>Reginald Quansah, PhD</td>
<td>Oulu, Finland</td>
<td></td>
</tr>
<tr>
<td>Amy Roberts, RN</td>
<td>Kansas City, MO</td>
<td></td>
</tr>
<tr>
<td>CDR Luis O. Rodriguez, MS, REHS/RS, CP-FS</td>
<td>Fort Lauderdale, FL</td>
<td></td>
</tr>
<tr>
<td>Paul Rosile, MPH, PhD, RS</td>
<td>Richmond, KY</td>
<td></td>
</tr>
<tr>
<td>Jeff Rubin, PhD, CEM, NREMT-B</td>
<td>Tigard, OR</td>
<td></td>
</tr>
<tr>
<td>Kenny D. Runkle, DPA, LEHP, REHS</td>
<td>Springfield, IL</td>
<td></td>
</tr>
<tr>
<td>Ben Ryan, MPH</td>
<td>Queensland, Australia</td>
<td></td>
</tr>
<tr>
<td>Ratul Saha, MSc, MS, PhD</td>
<td>New Brunswick, NJ</td>
<td></td>
</tr>
<tr>
<td>Michéle Samarya-Timm, MA, HO, MCHES, REHS, DAAS</td>
<td>Franklin Park, NJ</td>
<td></td>
</tr>
<tr>
<td>Fatih Sekercioglu, MSc, MBA, CIPHI(C)</td>
<td>London, Canada</td>
<td></td>
</tr>
<tr>
<td>CAPT Sarath Seneviratne, CIH, CSP, CBSP, CHMM, RBT, CET, REHS, MS, DAAS</td>
<td>Bethesda, MD</td>
<td></td>
</tr>
<tr>
<td>Behzad Shahmoradi, PhD</td>
<td>Sanandaj, Iran</td>
<td></td>
</tr>
<tr>
<td>Derek G. Shendell, MPH, DEnv</td>
<td>Piscataway, NJ</td>
<td></td>
</tr>
<tr>
<td>Samendra Sherchan, PhD</td>
<td>New Orleans, LA</td>
<td></td>
</tr>
<tr>
<td>Kevin Sherman, PhD, PE, DWRE</td>
<td>Crampbellsburg, KY</td>
<td></td>
</tr>
<tr>
<td>Jo Anna M. Shimek, MS, PhD, CIH, CSP</td>
<td>Bloomington, IN</td>
<td></td>
</tr>
<tr>
<td>Ivy Shiu, MSc, PhD</td>
<td>Newcastle upon Tyne, England</td>
<td></td>
</tr>
<tr>
<td>Zia Siddiqi, PhD, BCE</td>
<td>Atlanta, GA</td>
<td></td>
</tr>
<tr>
<td>Satheesh Sivasubramani, PhD</td>
<td>Galveston, TX</td>
<td></td>
</tr>
<tr>
<td>David A. Sterling, PhD, CIH</td>
<td>Fort Worth, TX</td>
<td></td>
</tr>
<tr>
<td>John A. Steward, MPH, REHS</td>
<td>Atlanta, GA</td>
<td></td>
</tr>
<tr>
<td>Major Michael C. Story, MPH, MBA, REHS/RS</td>
<td>Fort Sam Houston, TX</td>
<td></td>
</tr>
<tr>
<td>Roman Tandlich, PhD</td>
<td>Grahamstown, South Africa</td>
<td></td>
</tr>
<tr>
<td>M.L. Tanner, HHS</td>
<td>Swansea, SC</td>
<td></td>
</tr>
<tr>
<td>Sylvanus Thompson, PhD, CPHI(C)</td>
<td>Toronto, Canada</td>
<td></td>
</tr>
<tr>
<td>Lawrence J. Tirri, PhD</td>
<td>Las Vegas, NV</td>
<td></td>
</tr>
<tr>
<td>James Trout</td>
<td>St. Louis, MO</td>
<td></td>
</tr>
<tr>
<td>Rong Wang, PhD</td>
<td>New Haven, CT</td>
<td></td>
</tr>
<tr>
<td>Yi Wang, PhD</td>
<td>Indianapolis, IN</td>
<td></td>
</tr>
<tr>
<td>Chris J. Wiart, MPH, PhD</td>
<td>Denver, CO</td>
<td></td>
</tr>
<tr>
<td>Sacoby Wilson, MS, PhD</td>
<td>College Park, MD</td>
<td></td>
</tr>
<tr>
<td>Felix I. Zemel, MCP, MPH, CEHT, HHS, REHS/RS, CPO</td>
<td>Needham, MA</td>
<td></td>
</tr>
<tr>
<td>Tyler Zerweck, MPH, DrPH, REHS</td>
<td>Memphis, TN</td>
<td></td>
</tr>
<tr>
<td>Tao Zhan, PhD</td>
<td>Elk Grove, CA</td>
<td></td>
</tr>
<tr>
<td>Kai Zhang, MS, PhD</td>
<td>Buffalo, NY</td>
<td></td>
</tr>
<tr>
<td>Yougui Zheng, PhD</td>
<td>Houston, TX</td>
<td></td>
</tr>
<tr>
<td>Zheng Zhou, MS, PhD</td>
<td>Minneapolis, MN</td>
<td></td>
</tr>
<tr>
<td>Jinqiu Zhu, MS, PhD</td>
<td>Buffalo, NY</td>
<td></td>
</tr>
</tbody>
</table>
Starting Off With Impact: The NEHA 2017 AEC Keynote and Opening Session
By Kristie Denbrock (kdenbrock@neha.org)

Don’t miss the opportunity to hear Representative Brenda L. Lawrence (D-Michigan) deliver the NEHA 2017 Annual Educational Conference (AEC) & Exhibition Keynote on Monday, July 10 in Grand Rapids, Michigan. Representative Lawrence, a champion of environmental health, recently reintroduced the Environmental Health Workforce Act bill on April 5, 2017. The bill ensures that there is a consistent set of guidelines and standards for training and education of environmental health professionals across the nation.

“Every American deserves the right to safe drinking water, clean air to breathe, and a healthy community to raise their children,” stated Representative Lawrence. “This legislation will provide a roadmap to rebuilding the local public health workforce, restore our faith in government, and renew our commitment to our children’s quality of life.”

Following Representative Lawrence’s keynote presentation will be our Opening Session—Aiming for Equity—with Renée Branch Canady, MPA, PhD, chief executive officer of the Michigan Public Health Institute, leading a panel of experts to discuss present day issues in environmental justice.

Joining Dr. Canady on the panel will be Dr. Pamela Pugh, public health advisor for the City of Flint; Dr. Marcus Cheatham, health officer for the Mid-Michigan District Health Department; and Ponsella Hardaway, executive director of Detroit’s Metropolitan Organizing Strategy Enabling Strength (MOSES) organization.

This interactive panel will focus on fair treatment and opportunities for individuals to participate in discussions and to contribute to activities that can affect environmental health in their communities.

Let your voice be heard in the fair environmental health treatment of all people regardless of race, color, national origin, or income—join us for our exciting 2017 AEC Keynote and Opening Session. More information about the 2017 AEC can be found at www.neha.org/aec.

NEHA’s New Legal Epidemiology Webinar Series
By Ellen Cornelius (programs@neha.org)

Laws and policies are essential to environmental health issues. In fact, one can make a case that every one of the Centers for Disease Control and Prevention’s (CDC) greatest public health achievements of the 20th century can be attributed in part to legal interventions (Burris, Ashe, Levin, Penn, & Larkin, 2016). Over this summer, NEHA has made the somewhat elusive and politically charged topic of policy and health accessible to its local environmental health practitioners by hosting parts 1 and 2 of the Legal Epidemiology Webinar Series.

Legal epidemiology is an emerging field that blends the practice of developing and implementing health laws with the scientific evaluation of how laws can affect health. By partnering with CDC’s Public Health Law Program, NEHA exposed its local environmental health member base to this relevant, yet mysterious, topic. Using legal epidemiology principles and methods allows environmental health professionals to assess their own local laws and policies and use that information for evaluation and future program planning.

The first webinar held in May focused on a broad introduction to legal epidemiology and described how it could be used as a tool when advancing from data to policy. The second webinar brought a technical focus to the series and provided applied legal epidemiology examples. Both webinars, presentation slides, and presenter information are available for free on NEHA’s website at www.neha.org/legal-epidemiology.

You can register for the third and final webinar of the series, A Tool for Addressing Health in All Policies, being held on August 16 at 1:00 p.m. EDT. NEHA’s Dr. Sandra Whitehead will be speaking about Health in All Policies implementation at the local level. Learn more about legal epidemiology and register for the webinar at www.neha.org/legal-epidemiology.

Reference

NEHA Staff Profile
As part of tradition, NEHA features new staff members in the Journal around the time of their one-year anniversary. These profiles give you an opportunity to get to know the NEHA staff better and to learn more about the great programs and activities going on in your association. This month we are pleased to introduce you to one NEHA staff member. Contact information for all NEHA staff can be found on page 49.

Seth Arends
I graduated from the Metropolitan State University of Denver in 2014 earning a bachelor of fine arts degree with an emphasis in communication design. My career began at a small design firm, Ellen Bruss Design, located here in Denver. It was there that I began to translate my abilities into a professional atmosphere. That was the first time in my life where I was compensated while performing tasks I’m truly passionate about. It was an unfamiliar, liberating, and addictive feeling that forever changed my professional life.

After getting some wind under my wings, I began to attract more freelance clients for both print and web design. For 18 months, I...
created nearly any kind of branding collateral imaginable, from chap stick labels, logos, and commercial brochures to full-scale, interactive web destinations. But as freelancing gradually became a financial feast or famine situation each month, I began to search for a more secure position.

As an artist, I was satisfying my hunger for ideas, but not my hunger for meaning. In a perfect world, I could develop fantastic work that could contribute toward positive change in the world and in my own community. I not only wanted to create but also wanted to make a difference and feel good about the day’s work. I applied to various nonprofit organizations and specific educational design positions—any destination I felt I could add value and enjoy the work. In a series of fortunate events, I was eventually hired by NEHA as its graphic designer.

Working at NEHA has been a dream realized. I get my feet wet working in many design facets such as illustration, infographics, advertising, typography, photography, interactive design, and even animation, which means that the work is engaging. Considering the political climate, the public is in dire need of organizations such as NEHA, and being a part of that is rewarding. NEHA has provided a platform for me to development as a designer and the future is bright with many exciting projects on the horizon.

NEHA offers different membership options to suit your professional needs. From students and those just starting the profession all the way up to those retiring, NEHA has a membership for everyone. And you can select multiple year options and how you want to receive the Journal. Visit www.neha.org/membership-communities/join for more information.

Did You Know?

TABLE 1

<table>
<thead>
<tr>
<th>Emerged or Emerging Environmental Health Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dr. Tom Burke: Wicked National Environmental Health Problems</strong></td>
</tr>
<tr>
<td>Fracking</td>
</tr>
<tr>
<td>Infectious diseases (Ebola, Legionella)</td>
</tr>
<tr>
<td>Pesticides</td>
</tr>
<tr>
<td>Perfluorooctanoic acid (PFOA)</td>
</tr>
<tr>
<td>Environmental justice</td>
</tr>
<tr>
<td>Air pollution</td>
</tr>
<tr>
<td>Water resources</td>
</tr>
<tr>
<td>Agriculture</td>
</tr>
<tr>
<td>Climate</td>
</tr>
<tr>
<td>Wastewater infrastructure</td>
</tr>
</tbody>
</table>

NEHA has retained an ad agency, 3 Advertising (www.3advertising.com), to assist us in thinking through these and other related issues as we aim to promote, protect, and enhance the profession. We hope their preliminary efforts will be complete by the time of our 2017 Annual Educational Conference (AEC) & Exhibition, and that we might possess the intellectual embryo that will give rise to new approaches to consistently communicate among ourselves and the world around us.

If you want to weigh-in or learn more about the state of the profession, I encourage you to attend our 2017 AEC in Grand Rapids, Michigan, on July 10–13. The theme this year—Local Solutions. National Influence—will explore the profoundly local nature of the profession and how we might use our collective influence to improve the health of the nation. NEHA staff has assembled thought leaders, influencers, and subject matter experts in Grand Rapids, a town known for its walkability, accessibility, and family-friendly environment. Our opening and closing panel sessions will showcase fresh faces and have been designed to address some of the most important issues of our time: environmental health equity and sustainability.

I look forward to seeing you there, in part to discuss how we might begin the journey of reassembling the fragmented state of the environmental health profession.

ddyjack@neha.org
Twitter: @DTDyjack
May marked my two-year anniversary at NEHA’s helm. It’s been an amazing 24-month sojourn. Our association developments and progress are well described in our Annual Report available at www.neha.org. Therefore, I’d rather use this column to advance thought around a more sobering and provocative issue, my perception of the fragmented state of the environmental health profession.

Figure 1 is derived from one of my stock PowerPoint presentations. The agency names are not as important as what they symbolize in aggregate—a profession that is a classic example of the tragedy of the commons. There are at least 16 federal agencies with a bite of the environmental health apple. Collaboration and cooperation among the various players is intermittent at best and often occur as a function of the latest crisis that dominates the headlines. Think Flint, Zika, or fracking for recent examples of agency shotgun weddings, often courtesy of public outrage.

Professional and subject matter heterogeneity is also a contributing factor to the state of confusion regarding who we are and what we do. Please peruse Table 1 (see page 53). The left column presents content provided by Dr. Tom Burke, the widely respected and admired Johns Hopkins University professor. I have taken some liberties with the material he described at a recent National Academies of Sciences, Engineering, and Medicine workshop in Washington, DC. At that meeting, Dr. Burke characterized his list as wicked environmental health problems that desperately need attention. These challenges are, among other things, 1) socially complex, 2) difficult to define, 3) complex on spatial and temporal scales, and 4) affected by many interacting factors. I happen to agree with Tom and his list.

I happen to also agree with my colleagues from California and their list. Please digest the right column of Table 1, which was presented by my friends Josh Dugas and Steve Van Stockum at a recent California Environmental Health Association meeting in Anaheim. The Californians described emerging professional issues in California that will increasingly need attention. For the record, I also agree with Josh and Steve and their list.

Upon careful examination and comparisons of the two lists, you’ll observe overlap, maybe even a significant portion, though the overlap is described using dissimilar terminology. There is also a large disconnect between the content of the two lists. Both of my observations are troubling. Where the two lists align, they use different nomenclature to describe the challenges at hand. On the other end of the spectrum, there seems to be a chasm between the priorities articulated by those inside the beltway and those reported by local practitioners. This issue is a symptom of a larger problem that we need to overcome—simplicity in describing priorities and messaging within and outside the profession. I trust you see the merit in my observations.

In Words that Work: It’s Not What You Say, It’s What People Hear, Dr. Frank Luntz suggests that consistency matters in all things related to communications. My friends, our next cosmic journey is to harmonize our messaging and priorities, and to ensure they are packaged and presented in a manner that resonate with society’s values and beliefs. Let me be clear: federal, state, local, private sector, and academic environmental health professionals should use similar words to describe similar conditions, and we should generally agree on national priorities, taking into consideration some local variation.

Second, to be effective, we need to take into consider what people hear, not what we are saying. I suggest society hears wildly

continued on page 53
Inspect2Go™

- Easy
- Powerful
- Affordable

Environmental Health Software

Visit us at the NEHA AEC conference July 10-13 in Grand Rapids, MI
BOOTH #101

949.480.5500 | inspect2go.com
marketing@inspect2go.com
Every day, hundreds of Inspectors in Public Health and Government Agencies - Inspectors like Angie - use our Information Systems to minimize health risks and protect their public.

When Angie makes a call, her work is available to the department and the public within minutes. She always has the information she needs for maximum productivity and accuracy. Facilities are never missed and high-hazard establishment inspections are never late.

Call us today:
1.866.860.4224. Ext. 3366=DEMO
HealthSpace.com
Characteristics of Airborne Asbestos Concentrations in Korean Preschools

Abstract

The objective of this study is to evaluate the possibility or extent of asbestos pollution in small-scale preschools, which are asbestos-containing buildings (ACBs), and to provide management plans for them. Korea is legally managing preschools with a total ground area of 430 m² or above as ACBs, but is not legally regulating preschools smaller than 430 m² (small-scale preschools) that account for 90.4% of all preschools. Thus, this study selected 46 small-scale preschools in Seoul, collected airborne samples at 91 points, and analyzed the samples with phase contrast microscopy and transmission electron microscopy. The result by the ISO 10312 method satisfied the Korean Indoor Air Quality Control Act (≤0.01 fibers/cc) (International Organization for Standardization, 1995). The analysis result by the Asbestos Hazard Emergency Response Act method was lower than the filter background level. There is a method to remove or eliminate asbestos, but this method increases the risk of exposure to airborne asbestos, so it seems better to effectively maintain and manage the buildings of small-scale preschools to prevent airborne asbestos.

Introduction

Once thought of as a wonder mineral because of its inherent beneficial qualities that included resistance to fire, heat, and corrosion—as well as being strong, durable, flexible, and inexpensive—asbestos has now become regarded as a hazardous material (International Agency for Research on Cancer [IARC] Working Group, 2012). Asbestos has been produced in Korea since the 1930s, and asbestos imports increased as secondary industries rapidly developed in the 1970s. These imports decreased from 1997 when some forms of asbestos, such as crocidolite and amosite, were prohibited (Park, Choi, Ryu, Park, & Paik, 2008). Then in 2009, after the Kubota Coincidence in Japan, use, manufacturing, distribution, and import of asbestos and asbestos-containing materials were prohibited in Korea (Kang & Kim, 2010; Kim, 2009). In Korea, asbestos mostly was used as materials for slates, car brake linings, fire-prevention dusting agents, pipe laggings, firefighting garments, electric appliance insulators, and floor tiles (Paik & Lee, 1991). In particular, approximately 80–95% of imported asbestos was used as building materials until the late 1990s (Jeong, Cho, Park, & Lee, 2013).

The hazards and dangers presented by exposure to asbestos, including chrysotile, cause an increased likelihood of developing cancer of the lung, larynx, and ovary; mesothelioma (a cancer of the pleural and peritoneal linings); and asbestosis (fibrosis of the lungs) (IARC, 2012).

Thus, Seoul is surveying the use of asbestos in city-owned public buildings and carrying forward a project to eliminate asbestos. It is also actively engaged in drawing a map of asbestos in asbestos-containing buildings (ACBs), and conducting promotional and education programs on asbestos management. Korea has included an item on asbestos in the Indoor Air Quality Control Act for public facilities such as libraries, museums, hospitals, preschools, passenger terminals, and subway stations. Asbestos in small-scale preschools smaller than 430 m², however, is not legally managed. Out of 43,646 preschools, 39,440 (90.4%) were small-scale preschools in Korea as of July 2014, which indicates that many preschools are excluded from asbestos management plans (Comprehensive Information Network for Asbestos Management, 2014). As a result of actually selecting and investigating 100 small-scale preschools smaller than 430 m² in the metropolitan area (Seoul, Incheon, and Kyeonggi), an area that accounts for half the population in our country, 8 out of the 29 schools (27%) in Seoul, 7 out of the 20 schools (35%) in Incheon, and 15 out of the 51 schools (29%) in Kyeonggi were identified, confirming that 30 (30%) out of the 100 small-scale preschools were made of asbestos-containing materials (Ministry of Health and Welfare [Korea], 2012).

Childcare for Korean children is heavily dependent on preschools as both parents are often engaged in economic activities. In addition, they want their children to receive quality education. Moreover, children spend most of their day in indoor spaces and are thereby susceptible to the indoor air quality; thus, parents prefer preschools with pleas-
ant facilities and perceived better indoor air quality. There is no clear evidence indicating that children are more at risk than adults to asbestos exposure (Agency for Toxic Substances and Disease Registry, 2001). Children, though, can have a longer period of exposure to asbestos and therefore an earlier onset possibility of asbestos-related diseases.

Therefore, the objective of this study is to test the airborne asbestos concentrations in small-scale preschools built within ACBs in Seoul, and reduce the potential harm caused by asbestos by providing accurate information and an effective management plan.

Materials and Methods

Survey Period and Site
Samples were collected from a total of 91 points in 46 separate small-scale preschools at 20 boroughs in Seoul during 9 months, from April to December 2015, surveying airborne asbestos concentrations (Figure 1). Samples were collected from living spaces often encountered by children and teachers, as well as places where there might have been exposure to asbestos (Figure 2).

Sample Collection and Analysis Method
Sampling was conducted at locations within the indoor facilities. These locations were chosen to minimize changes in wind or airflow and the sampling was conducted by an air trapping method with an airflow rate of 10 L/min to detect dust concentrations. In all, 1,210 L was sampled for 2 hours. A SARA-4000 Asbestos Sampler was used for the sampling of airborne asbestos in preschools. A mixed cellulose ester membrane filter (0.8 μm pore size, 25 mm diameter) was used as the sampling filter. We measured samples in accordance with the indoor air quality standards of “Indoor air—How to measure the concentration of asbestos dust and fiber-phase microscopy” announced by Korea ES 02303.1 (Notice of Ministry of Environment No. 2010-24) (Ministry of Environment of Korea, 2010).

Samples were conducted in accordance with the aceton/triacetin method and then expressed as concentrations of fibrous materials (in f/cc) at a magnification of 400 times by phase contrast microscopy (PCM) inserted into the Walton–Beckett eyepiece graticule (Lange, 2001). Airborne fibrous materials were counted as fibrous (including asbestos) when the fibers had a length of >5 μm and a ratio of at least 3:1 in diameter.

When the result of analyzing with PCM exceeded 0.01 f/cc (the Indoor Air Quality Control Act criterion), we prepared the remaining samples without an additional sample collection, and analyzed them with transmission electron microscopy (TEM) according to the ISO 10312 method (International Organization for Standardization [ISO], 1995).

Samples were analyzed at 18,500x magnification, which were counted as asbestos f/cc according to the ISO 10312 rule (ISO, 1995), while asbestos structures/cc (s/cc) were counted according to the Asbestos Hazard Emergency Response Act (AHERA) rule (U.S. Environmental Protection Agency, 1987). Airborne asbestos concentrations of small-scale preschools were examined by determining whether the airborne fibrous materials from the PCM analysis results were actual asbestos fibers.
Results

Management of Asbestos in Small-Scale Preschools

We selected 46 small-scale preschools in Seoul, collected samples from 91 points, and analyzed them with PCM and TEM. We found that for ACB materials in preschools, textiles accounted for at least 80% of the asbestos materials, and the remaining 20% was made up of baumlite and slate. Of the 46 preschools, 44 of them were being managed in a satisfactory condition, while two were likely to reveal the presence of airborne asbestos; 34 of them had indoor wallpapers or paint on the walls (Table 1).

Airborne Fibrous Materials With PCM

PCM test results showed that four (classroom, bathroom, lounge, corridor) out of the seven spaces or rooms monitored had average concentrations of fibrous materials at 0.01 f/cc or above, which is the Indoor Air Quality Control Act criterion (Ministry of Environment of Korea, 2017). Overall, the distribution was 0.000–0.040 f/cc (Table 2, Figure 3). Of the total 91 points, 29 points exceeded 0.010 f/cc, but we used TEM for a precise analysis, as the measured fibrous materials cannot be assumed to be asbestos.

Airborne Fibrous Materials With TEM

As a result of analysis with sensitivity 0.0009 f/cc according to the ISO 10312 method (length ≥ 0.5 μm, width > 0.25 μm, length-to-width ratio ≥ 3:1), 0.0072 s/cc (teachers room) and 0.0036 s/cc (classroom) of chrysotile were detected in two preschools. These numbers are lower than the filter background level. Chrysotile, however, was not detected in any of the other preschools (Figure 4).

On the other hand, even though it was expected that airborne asbestos would be detected in the two preschools that contain it, surprisingly, airborne asbestos was not detected in these two schools. By construction year, 39 out of the 46 preschools (85%) were constructed in the 1980s and 1990s, and asbestos was detected in one preschool constructed in the 1980s and one preschool constructed in the 1990s by applying the AHERA method (length ≥ 0.5 μm, width > 0.25 μm, length-to-width ratio ≥ 5:1) (Table 3).

Discussion

We examined asbestos concentrations obtained at 91 points from 46 small-scale preschools that were smaller than 430 m² in Seoul, and they all complied with the Indoor Air Quality Control Act (≥ 0.01 f/cc). Any particle longer than 5 μm in length shall be defined as an asbestos fiber according to Korean law. A particle of the minimum length of 0.5 μm, however, is defined as asbestos fiber in the U.S. (AHERA method), so we sought to detect and identify the distribution of fibers that were less than 0.5 μm.

Chrysotile was found in two preschools, in a teachers room and a classroom, at lower than the filter background level. The principal varieties of asbestos are a serpentine material called chrysotile, and crocidolite, amosite, anthophyllite, tremolite, and actino-

---

### TABLE 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Asbestos-Containing Materials</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>Damaged</td>
<td>Textile</td>
</tr>
<tr>
<td></td>
<td>Textile and Baumite</td>
<td>Baumlite</td>
</tr>
<tr>
<td></td>
<td>Slate</td>
<td>Wallpaper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paint on the Walls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
</tr>
<tr>
<td>44</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Note. The damage level, types of asbestos-containing materials, and interior status were examined by on-site visits to the preschools.

### TABLE 2

<table>
<thead>
<tr>
<th>Places</th>
<th># of Samples</th>
<th># of Exceeded Samples</th>
<th>Maximum (f/cc)</th>
<th>Minimum (f/cc)</th>
<th>Mean ± SD (f/cc)</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers room</td>
<td>13</td>
<td>3</td>
<td>0.035</td>
<td>0.000</td>
<td>0.009 ± 0.010</td>
<td>Indoor Air Quality Control Act (≤ 0.01 f/cc)</td>
</tr>
<tr>
<td>Classroom</td>
<td>41</td>
<td>16</td>
<td>0.031</td>
<td>0.002</td>
<td>0.010 ± 0.008</td>
<td></td>
</tr>
<tr>
<td>Bathroom</td>
<td>7</td>
<td>3</td>
<td>0.026</td>
<td>0.006</td>
<td>0.012 ± 0.007</td>
<td></td>
</tr>
<tr>
<td>Lounge</td>
<td>3</td>
<td>2</td>
<td>0.022</td>
<td>0.004</td>
<td>0.013 ± 0.009</td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td>3</td>
<td>0</td>
<td>0.003</td>
<td>0.002</td>
<td>0.003 ± 0.001</td>
<td></td>
</tr>
<tr>
<td>Corridor</td>
<td>3</td>
<td>1</td>
<td>0.011</td>
<td>0.009</td>
<td>0.010 ± 0.001</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>21</td>
<td>4</td>
<td>0.040</td>
<td>0.000</td>
<td>0.007 ± 0.008</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>29</td>
<td>0.040</td>
<td>0.000</td>
<td>0.009 ± 0.008</td>
<td></td>
</tr>
</tbody>
</table>

Note. The concentration (f/cc) is determined by counting only fibers with length > 5 μm and a length-to-width ratio of ≥ 3:1.

*The number of places in which concentrations of airborne fibrous materials exceeds 0.010 f/cc.
lite—which are a type of dark mineral called amphiboles (Mirabelli et al., 2008). All detected asbestos was chrysotile, which was less than 10 μm long. Chrysotile, if smaller than 20 μm, generally can be broken down in the body, but other amphiboles are deposited on the diaphragm, causing fibrosis (Bernstein et al., 2013).

All detected chrysotile was less than 10 μm, and thus presented a low risk. Asbestos was barely detected in small-scale preschools smaller than 430 m² in Seoul, even though they are ACBs. This finding is because most preschools naturally prevented airborne asbestos by using wallpapers, paints, and silicon finishes in the interior for heat insulation. By construction year, the preschools constructed in the 1980s and 1990s accounted for the highest percentage, and one of the preschools where asbestos was detected was a preschool located in the Gangnam borough, which is an economically advantaged area in Seoul.

Korea has prohibited the use of asbestos since 2009, and thus new buildings are made of non-asbestos materials. The problem is that many preschools built before 2009 are ACBs, and therefore present a real risk of exposure to asbestos for inhabitants—a risk which must be managed.

In general, there are two ways to reduce the risk from asbestos.

1) Dismantle and remove the asbestos. Asbestos is likely to be emitted in the process of dismantling it, and the need for containment will also generate costs. When dismantling asbestos buildings, it is necessary to establish a systematic plan and methods to prevent airborne asbestos.
2) Maintain and manage the buildings by establishing prevention methods (enclosure, encapsulation, repair). Airborne asbestos can be managed safely by preventing damage to ceiling textiles and paint on walls and ceilings, by using wallpapers and gap-filling materials, and by applying stabilizers.

There was also a report in the U.S. that asbestos concentrations are not high in buildings on a daily basis, and thus it is appropriate that the risk be managed instead of removing the asbestos (Lee & Van Orden, 2008). Asbestos was barely detected in this study, confirming that the asbestos exposure levels are not high in preschools on a daily basis.

The risk posed by asbestos is emerging as a major social issue in Korea. This issue is only natural considering the fact that asbestos is a carcinogen that was commonly used in Korea and also that there is greater interest in and awareness of matters related to health and safety. Excessive concerns over the risk of exposure to asbestos, however, may create social fear and confusion. Countries such as the U.S. assume, in the managerial sense, that asbestos poses little risk as long as it is not emitted in the air, and management plans are established accordingly. Therefore, it is desirable for Korea also to establish maintenance plans in consideration of the potential for airborne asbestos, as well as the costs associated with managing the risk (Yoon, 2009).

The metropolitan government in Seoul is continuing to remove asbestos in multiuse

---

**FIGURE 3**

Distribution of the Airborne Concentrations of Fibrous Materials Detected With Phase Contrast Microscopy

![Graph showing distribution of airborne asbestos concentrations](image-url)
buildings owned by the city year by year. This action is taken out of consideration for the health of citizens, as many citizens use such buildings. Considering the fact that most small-scale preschools are private properties where asbestos is rarely detected, it is desirable to implement strict preventive measures and perform regular monitoring. We believe that it is possible to be safe from asbestos as long as we properly maintain and manage the buildings containing asbestos, like the small-scale preschools in this study. In other words, despite the harmfulness of asbestos, the risks can be reduced by effective maintenance to prevent airborne emission.

**Conclusion**
Young children in the process of physical development have weaker immune systems and are more sensitive to pollutants than adults—thus it is important to establish measures to prevent airborne asbestos in preschools that were built with materials containing asbestos. In particular, even though small-scale preschools smaller than 430 m$^2$ account for 90.4% of preschools in Korea, there are no legal standards for the detection, control, and management of asbestos in such places. This study examined airborne asbestos concentrations in small-scale preschools and discovered that the asbestos levels met national standards, even though a small amount of chrysotile was detected in a few of the preschools. Most preschools were preventing exposure to asbestos because walls and ceilings were covered with wallpapers and paints. Therefore, the most appropriate method is to regularly monitor asbestos, develop and apply effective measures and technology to prevent airborne asbestos, and minimize exposure to asbestos until it is removed.

**Acknowledgement:** The authors would like to thank director Seokju Cho; Miok Song, PhD; and Jinhyo Lee, PhD, from the Seoul Institute of Health and Environment for providing invaluable advice and input.

**Corresponding Author:** Changkyu Kim, Particle Research Team, Institute of Public Health and Environment, Seoul Metropolitan Government Research, 202-3, Yangjae-dong, Seocho-gu, Seoul, Korea, 137-130.
E-mail: ckkim0707@seoul.go.kr.

**References**
References


