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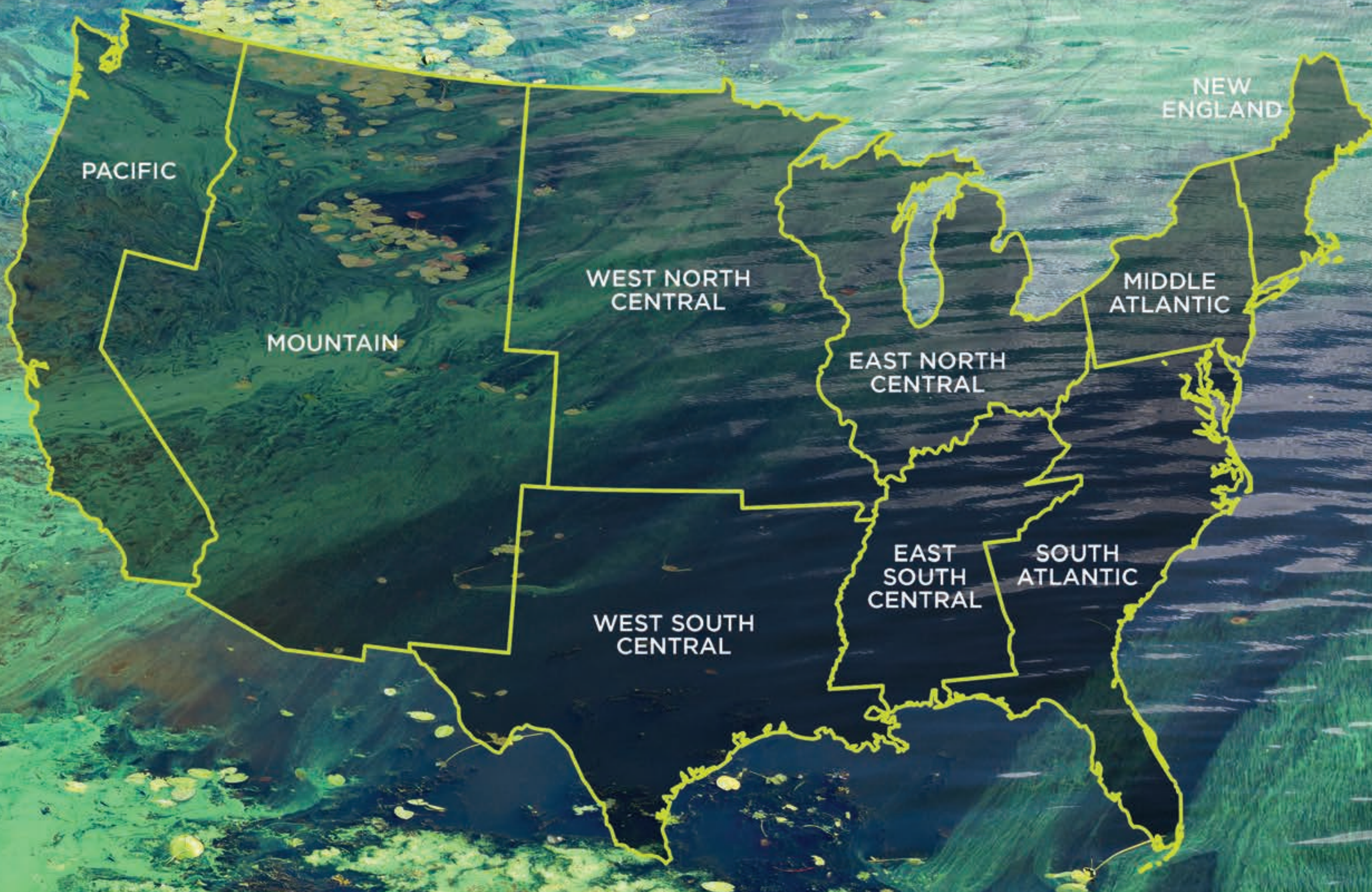

Harmful Algal Bloom Exposure in the U.S.

Evaluating Electronic Health Records to Measure Illness

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ABOUT THE COVER

Harmful algal blooms (HABs) are the rapid growth of algae that can produce toxic or harmful effects in people and animals. Defining HAB exposure and related illness can be challenging. This month's cover article, "Evaluation of Electronic Health Records to Monitor Illness From Harmful Algal Bloom Exposure in the United States," queried the MarketScan Research Databases between January 2009 and April 2019 for use of the International Classification of Diseases (ICD) codes for HAB exposure. The study found that although the HAB-related ICD-9 and ICD-10 codes were used infrequently, they were most often recorded during bloom seasons in warmer months. This analysis is the first that utilizes a large-scale national database of de-identified health records to understand the use of medical diagnostic codes related to algae exposure.

See page 8.

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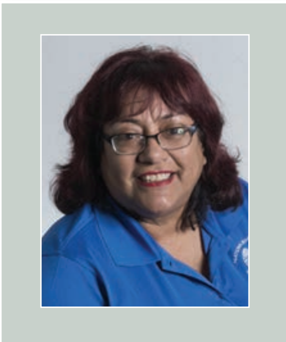

Sandra Long, REHS, RS

Advocating for the Profession

The National Environmental Health Association (NEHA) Board of Directors allocates time in the spring to meet with senators and representatives on Capitol Hill to educate, discuss, and present information on environmental health issues. The purpose is to garner support for environmental health. This year, due to the pandemic and other events, the NEHA board will be having virtual meetings for this purpose.

The board enters these meetings well prepared with talking points, specific items to be addressed, and a designated amount of time to share our message. Most of these meetings start with explaining what environmental health is. Many times, legislators think we are there to talk about saving trees or polluted water. I like to start with asking them if they had any concerns about the water used in their morning coffee, or if they were concerned about getting sick from the food they consumed if they stopped somewhere for breakfast, or if they had any concerns about mosquito-borne illness. I follow this line of questions to illustrate that environmental health is at work to ensure that the public is safe and do not have to question these things. It makes legislators realize the scope of environmental health. The education we provide includes defining environmental health and highlighting the various programs, job titles, and roles we play in keeping everyone safe on a daily basis.

As legislators are in session in our respective states, we need to diligently track bills that could affect environmental health. From a political perspective, legislators want to do what is best for the population they represent, which could mean sources of income for businesses or families. They might not be aware of the impact on environmental health. To assist you, NEHA has policy and position statements that are accessible on the NEHA website to support environmental health positions on various topics (www.neha.org/policy-position-statements). These statements are routinely updated utilizing subject matter experts and NEHA staff.

It is our responsibility as environmental health professionals to provide our expertise in legislative matters.

We need to remember that representatives and senators work for us. With environmental health professions in the forefront for the past year—putting pandemic protocols in place, working with concurrent emergency issues, and more recently assisting in coordinating vaccine efforts, all while maintaining daily operations—it is an optimum time for us to remind legislators of our duties that we perform on a daily basis. Inform them of the importance of environmental health and how it affects all aspects of daily life for every resident. We need to educate and make legislators aware of the issues they are or will be discussing. Do we want to save an economy but make people sick in the process? Some look at bills only from a financial perspective and the economic impact it will have on a community, not seeing or being unaware of the environmental health impacts that certain legislation could bring. Cottage foods, raw milk, and home restaurants are examples of legislation that if passed without input from environmental health, could result in regulations (or a lack of regulation) that negatively impact environmental and public health.

As practitioners of environmental health, we need to not only take an interest in environmental legislation but also be stewards of the profession and voice our input on the issues raised. Contact your representatives with science-based information on the legislation at hand. This outreach is an opportunity to educate them on what environmental health is and how the legislation they are proposing impacts environmental and public health. When approached with sound, science-based information, presented in a clear and logical manner, representatives are provided with information that is tracible and credible. They are not being presented with opinions that do not have merit; conversely, they are being presented with fact-based information to consider.

What many do not realize is that our legislators are not experts in the areas in which they champion legislation. They rely on information provided by the person or group who proposed the legislation. When legislation is sent to various committees for deliberation, committee members, many of whom do not have expertise of the subject matter presented in the legislation, hear the information provided and weigh that information against the possible outcomes. It is important, therefore, for us as environmental health professionals to be aware of the committees and their members so that we can present information that is valuable to the decision-making process. Always keep in mind that we are the experts, we are the personnel that have experience with environmental health issues. In the end, once legislation goes into effect, we are the "boots on the ground" who are impacted by the outcomes, either positively or negatively.

While many are not comfortable with contacting legislators, a letter or email is simple to write. Your message does not need to be long but it should be supported with fact-based information. Remember that every voice counts and it is our responsibility as environmental health professionals to provide our expertise in legislative matters.

NEHA Hill Day 2021 will take place on April 22. On this day, NEHA board members and staff leadership will speak to senators and representatives of the 117th U.S. Congress on environmental health issues in a virtual format. Our goal is to educate and inform these legislators and to keep environmental health in the forefront. We undertake this endeavor because of our dedication to the profession. I encourage you to do the same with your state and local legislators.

Sandra Long
President@neha.org

SUPPORT THE NEHA ENDOWMENT FOUNDATION

The NEHA Endowment Foundation was established to enable NEHA to do more for the environmental health profession than its annual budget might allow. Special projects and programs supported by the foundation will be carried out for the sole purpose of advancing the profession and its practitioners.

Individuals who have contributed to the foundation are listed below by club category. These listings are based on what people have actually donated to the foundation—not what they have pledged. Names will be published under the appropriate category for 1 year; additional contributions will move individuals to a different category in the following year(s). For each of the categories, there are a number of ways NEHA recognizes and thanks contributors to the foundation. If you are interested in contributing to the Endowment Foundation, please call NEHA at (303) 756-9090. You can also donate online at www.neha.org/about-neha/donate.

Thank you.

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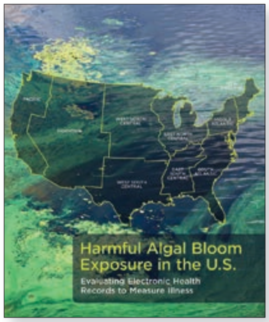


Evaluation of Electronic Health Records to Monitor Illness From Harmful Algal Bloom Exposure in the United States

Amy Lavery, MSPH, PhD
Lorraine Backer, PhD
Johnni Daniel, DHSc
National Center for Environmental Health, Centers for Disease Control and Prevention

Abstract **Harmful algal blooms (HABs) are the rapid growth of algae that can produce toxic or harmful effects in people and animals. Potential health effects include respiratory illness, gastrointestinal illness, skin and eye irritation, and sometimes more severe toxic effects such as liver damage. Defining HAB exposure and related illness is challenging for many reasons, including characterizing the exposure. Large electronic health record databases present an opportunity to study health encounters specifically related to HAB exposure through querying medical diagnostic codes. We queried the MarketScan Research Databases between January 2009 and April 2019 for use of the International Classification of Diseases (ICD) codes for HAB exposure. We found a total of 558 records that used either the ICD-9 or ICD-10 code for HAB exposure. Respiratory illness was most commonly reported along with the HAB exposure code. Use of HAB exposure codes showed seasonal fluctuations during 2012–2019. We found that although the HAB-related ICD-9 and ICD-10 codes were used infrequently, they were most often recorded during bloom seasons in warmer months. This analysis is the first that utilizes a large-scale national database of de-identified health records to understand the use of medical diagnostic codes related to algae exposure.**

Introduction

Harmful algal blooms (HABs) are the rapid growth of algae that can produce toxic or harmful effects in people and animals (National Oceanic and Atmospheric Administration, 2020). Short-term health effects have been associated with HAB exposure through skin contact, ingestion, or inhalation of algal toxins. Health effects include respiratory illness, gastrointestinal illness, skin and eye irritation, and sometimes more severe toxic effects such as liver failure or paralysis (Centers for Disease Control and Prevention, 2020; Fleming et al., 2011; National Institute of Environmental Health Sciences, 2021). HABs are increasing in frequency and duration within the U.S., presenting an increased risk for adverse health outcomes associated with exposure (Davis & Gobler, 2016). Information about the prevalence and long-term health effects of HAB exposure is more limited.

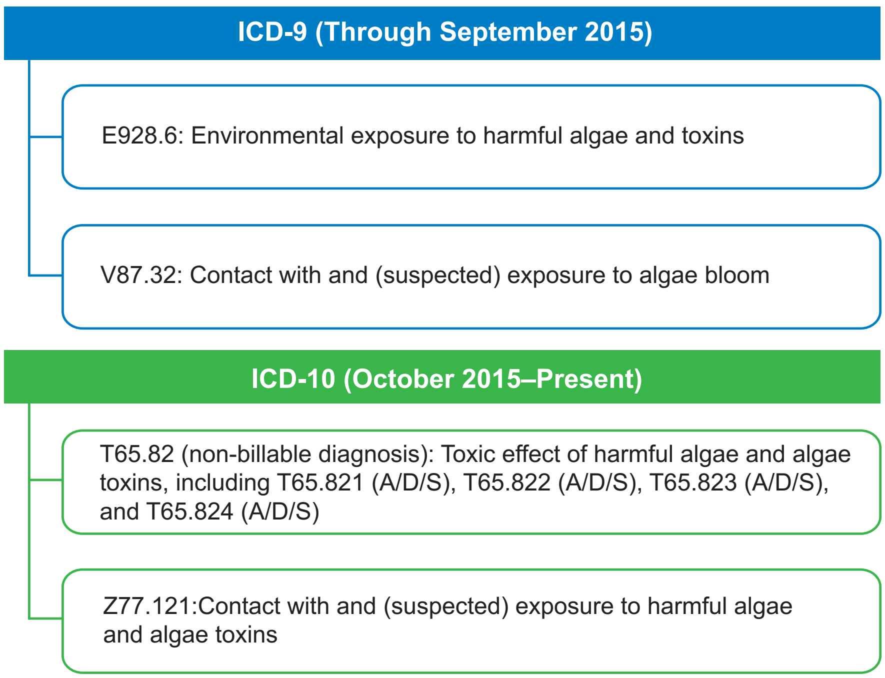
Defining HAB exposure and related illness is difficult due to challenges with characterizing and reporting HAB contact (Backer et al., 2015; Bradley et al., 2013; Serrano et al., 2015; Torbick et al., 2018). Electronic health records (EHRs) present an opportunity to study health encounters specifically related to HAB exposure through use of medical diagnostic codes. Figure 1 presents the International Classification of Diseases (ICD) codes available to classify HAB exposures (ICD-9 and ICD-10) and toxic effects of HABs (ICD-10 only) during a medical encounter (hereafter referred to as HAB exposure codes). Important to note for this analysis, we excluded HAB exposure related to seafood poisonings and concentrated on environmental exposures to HABs.

Only one study has examined the utility of HAB exposure diagnostic codes; however, the analysis was limited to the state of New York and to the use of ICD-9 codes (medical facilities have been using ICD-10 codes since 2015) (Figgatt et al., 2016). It is unclear how these diagnostic codes are used across the U.S. and how the updated ICD-10 codes might result in different or improved HAB-related illness classification.

If medical diagnostic codes for HAB exposure are used effectively, EHRs could provide a platform for enhanced surveillance of HAB exposures and related illnesses, including potential assessment of long-term health effects. Additionally, assessing corresponding procedure or laboratory codes used during the medical encounter might provide insight into health effects that have not been extensively studied. The purpose of this study was to

FIGURE 1

ICD Codes for Harmful Algal Bloom Exposure



ICD = International Classification of Diseases; A = initial encounter; D = subsequent encounter; S = sequela.

evaluate the use of ICD-9 and ICD-10 medical diagnostic codes for HAB exposure across the U.S. using a large, de-identified EHR database.

Methods

Description of Data Set and Study Population

We used the IBM MarketScan Research Databases (IBM Watson Health), which contain de-identified healthcare claims data for individuals with commercial insurance and some Medicaid beneficiaries. The Commercial Claims and Encounters Database (hereafter referred to as Commercial database) contains data from currently employed persons and their dependents, former covered employees insured using the extended COBRA plans, and early retirees who are not eligible for Medicare (IBM Watson Health, 2017). The Medicaid Database includes data from several state-based Medicaid programs for individuals covered under the fee-for-service and managed care plans (IBM Watson Health, 2017).

A convenience sample of claims records across the U.S. was used to populate both databases. Records include physician office visits, hospital stays (inpatient and outpatient), pharmacy orders (outpatient pharmacy orders), and other healthcare services such as mental health care. Available variables in the Commercial database include age, sex, proximate events that occur on the same day as the event of interest, region of occurrence, cost of medical visit, and hospitalization status including length of stay. Available variables in the Medicaid database include age, sex, race, proximate events that occur on the same day as the event of interest, cost of visit, and hospitalization status.

For this analysis, we selected the two most recent data sets within MarketScan for Commercial and Medicaid claims. The most recent Commercial data set was available for approximately 90 million people between January 1, 2012, and April 30, 2019. The most recent Medicaid data set was available for approximately 23 million people between January 1, 2009, and December 31, 2018. This study was exempt from Centers for Disease Control and Prevention Institutional Review Board approval because secondary data were used and did not constitute human subject research.

Cohort Creation

Data were accessed for this project through the online MarketScan Treatment Pathways portal. In the portal, a cohort of records was created in both the Commercial and Medicaid databases using the ICD-9 and ICD-10 HAB exposure codes for categories and subcategories (Figure 1).

The created cohorts then consisted of any patient who had an ICD code of interest along with an "index date" for when the code was assigned. The index date corresponds to the first time that ICD code was used for that person and was used to add that record into the cohort. The two cohorts were then analyzed separately to compare results from the two databases.

Analysis

Data were analyzed using the MarketScan Treatment Pathways portal, Excel, and Stata statistical software version 15. Basic demographic information was summarized by frequency of occurrence and percentage of the overall records within the cohort. The total number of records in the two databases (Commercial and Medicaid) was charted by year and quarter to visualize changes in occurrence over time and season. For the Commercial database only, the number of events occurring by U.S. Census Bureau region was displayed and visualized using ArcMap version 10.5.1. Additional health events and procedures were evaluated and described that occurred on the index date that the HAB exposure code was used.

Results

A total of 558 records contained one of the HAB exposure codes, including 380 records in the Commercial database and 178 records in the Medicaid database. Within the two databases, 366 records were coded using the ICD-9 classifications while 192 were coded using the ICD-10 classifications. ICD-9 coding transferred to ICD-10 in October 2015 and ICD-10 was the only available coding system starting in 2016.

Table 1 shows the demographic makeup of the records within the two cohorts. The majority of records were for individuals between the ages of 18–44 (33%) and 45–64 (44%) in the Commercial cohort and under the age of 18 in the Medicaid cohort (62%). Although the cost of a medical visit was somewhat low (median was $122 for the Commercial cohort and $61 for the Medicaid cohort), some visits cost several thousands of dollars for a hospital stay lasting for >1 week. Within both cohorts, 144 people had a hospital inpatient or emergency department visit on the same day in which the HAB exposure code was used. Due to the nature of the database, it is unclear if the hospital stays were directly associated with the HAB exposure code.

Figure 2 shows the number of records with an HAB exposure code in both cohorts by quarter and year, starting in 2012 when both data sets were available. Overall, 2014 and 2018 were the years with the most use of HAB exposure codes. As expected, more HAB exposure code records occurred during the spring and summer months (April–September), which comprise quarters 2 and 3 in Figure 2. The earlier years using ICD-9 codes lacked pronounced peaks during quarters 2 and 3 during 2012 and 2013, whereas the ICD-10 codes had more defined seasonal peaks for the years with complete quarterly reports. In 2018, a large peak was present in quarters 3 and 4 corresponding with a large-scale red tide event in August–November 2018. HAB exposure code use was more prominent in the South Atlantic region, followed by the East North Central and Middle Atlantic regions (Figure 3).

Table 2 displays the top 5 diagnostic codes that were used for people on the same day that an HAB exposure code was used. Respiratory events such as cough and shortness of breath were most often used (16.3%). Codes documenting an allergy were used for 38 people (6.8%). The top 100 diagnostic codes used at the same time as an HAB diagnosis code were grouped into common disorders associated with HAB exposure. These groupings included respiratory events (e.g., asthma, shortness of breath); neurological events (e.g., headache, dizziness); gastrointestinal events (e.g., diarrhea, vomiting); and skin and eye irritation events (e.g., conjunctivitis, rash). When combining cohorts, approximately 207 individuals (37.1%) had

TABLE **1**

Demographic Characteristics of MarketScan Data Cohorts With Harmful Algal Bloom Exposure (ICD) Codes

Characteristic	Commercial Claims[a] January 1, 2012–April 30, 2019		Medicaid Claims[a] January 1, 2009–December 31, 2018	
	Count (*N* = 380)	Frequency (%)	Count (*N* = 178)	Frequency (%)
Age				
0–17	63	16.6	111	62.3
18–44	125	32.9	45	25.3
45–64	167	43.9	22	12.4
≥65	25	6.6	–	–
Sex				
Female	204	53.7	94	52.8
Male	176	46.3	84	47.2
Race				
Black	–	–	43	24.2
Hispanic	–	–	–[b]	–[b]
White	–	–	100	56.2
Other	–	–	–[b]	–[b]
Region				
East North Central	54	14.2	–	–
East South Central	30	7.9	–	–
Middle Atlantic	53	13.9	–	–
Mountain	21	5.5	–	–
New England	25	6.6	–	–
Pacific	34	8.9	–	–
South Atlantic	115	30.3	–	–
West North Central	–[b]	–[b]	–	–
West South Central	38	10.0	–	–
Urban/rural				
Urban	326	85.8	–	–
Rural	49	12.9	–	–
Inpatient or emergency visits	66	17.4	78	43.8
	Median	**Interquartile Range**	**Median**	**Interquartile Range**
Cost of medical visit (U.S. dollars)	$122.34	$75.69–$200.82	$61.16	$8.99–$105.09
Length of hospital stay (days)[c]	4	3–7	–	–

ICD = International Classification of Diseases.

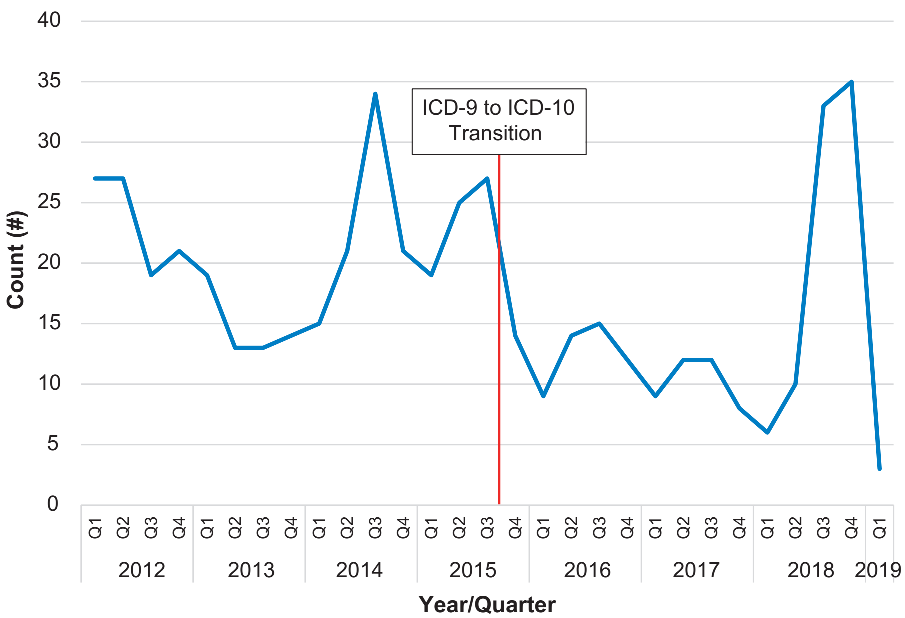
[a]The Commercial claims database did not have data on race; the Medicaid claims database did not have data on region or urban/rural residence.

[b]Data suppressed due to small sample size.

[c]Length of stay for any visits resulting in hospitalization. Only one person in the Medicaid database was hospitalized (4 days total).

FIGURE 2

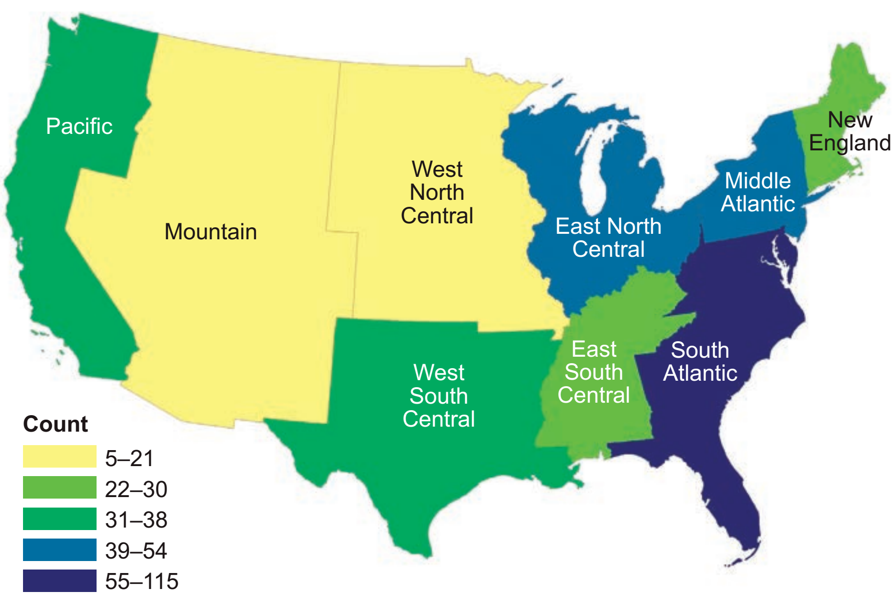
Count of Harmful Algal Bloom ICD Codes by Year From January 1, 2012–April 30, 2019, MarketScan Data



ICD = International Classification of Diseases; Q1 = January–March; Q2 = April–June, Q3 = July–September; Q4 = October–December.

FIGURE 3

Count of Harmful Algal Bloom ICD Codes by Region From January 1, 2012–April 30, 2019, MarketScan Data



ICD = International Classification of Diseases.

respiratory events recorded on the same day an HAB code was used for them. Fewer records listed neurological events such as headaches and dizziness ($n = 66$, 11.8%); eye or skin irritation ($n = 61$, 10.9%); or gastrointestinal events ($n = 32$, 5.7%).

Several procedures were listed for the same days as the HAB exposure code visit. Many of the procedures documented were for overall medical evaluations. Several blood draw tests were ordered as part of these medical workups as well. For 29 individuals (5.2%) in the cohort, an inhalation treatment was ordered to assist with acute airway obstruction or difficulty breathing.

Discussion

MarketScan data provided an initial platform to investigate the use of HAB exposure diagnostic codes across the U.S. While this database is limited mostly to individuals insured with commercial or employer-based plans, the database provided >90 million Commercial claims records and >20 million Medicaid claim records to review. The main finding from this analysis is that ICD codes for HAB exposure are used infrequently. The data set, however, provided an opportunity to examine whether the ICD-10 codes were used more often or in a more specific way to document HAB exposure than the ICD-9 codes.

Although a relatively small number of records were available in this data set, Figure 2 shows that the use of HAB exposure codes corresponds mostly to the time of year that HAB events occurred, namely during the warmer months when conditions are conducive to algal growth. Interestingly, we observed a difference in age categories when comparing records in the Commercial database and the Medicaid database. A majority of the records in the Medicaid database with HAB exposure codes were for children and teenagers under the age of 18 (62%) compared with more records between the ages of 18–64 in the Commercial database. It is unclear why we saw this difference between the two databases. As of 2019, approximately 71 million people in the U.S. were covered under Medicaid, a large percentage of whom are children (50%) (Mikulic, 2020). Although the Commercial database contains some dependents within it, it is possible that not as many children are covered within this database compared with the Medicaid database, although we could not validate this assumption in our analysis.

Summarizing the other diagnostic codes that were used at the same time as an HAB exposure code helped to identify common health complaints related to these exposures. As expected, the most common ICD codes reported at the same time as an HAB exposure code were those for respiratory events and were most likely associated with the presence of *Karenia brevis* red tides in the Gulf of Mexico (Backer et al., 2005; Fleming et al., 2011; Kirkpatrick et al., 2006). A large peak in HAB exposure code use occurred during a particularly intense red tide event in the Gulf of Mexico in August–November 2018. Examination of the data by region corroborated this assumption, as the South Atlantic region contained approximately 30% of the total records. These results correspond to a study of emergency department admissions in 2002 in Florida that found a significant increase in the rate of admissions for respiratory disease during a red tide event compared with a time when there was no red tide (Kirkpatrick et al., 2006).

TABLE **2**

Top 5 ICD-9 and ICD-10 Health Diagnostic Codes Associated With a Harmful Algal Bloom Exposure Visit

Event Name	# of Individuals	Frequency (%)
ICD-9		
786.2: Cough	42	7.5
995.3: Allergy, unspecified	38	6.8
780.79: Other malaise and fatigue	16	2.9
784.0: Headache	12	2.2
V70.0: Routine general medical examination at a healthcare facility	12	2.2
ICD-10		
R05: Cough	37	6.6
R0602: Shortness of breath	12	2.2
I10: Essential (primary) hypertension	11	2.0
J029: Acute pharyngitis, unspecified	11	2.0
J069: Acute upper respiratory infection, unspecified	11	2.0

ICD = International Classification of Diseases.

Interestingly, the next highest count of respiratory events (coded on the same visit as an individual's HAB exposure code) was in the East North Central region that comprises many Great Lakes states. Other blooms, such as cyanobacterial harmful algal blooms (cyanoHABs), could be the source of respiratory irritants in this region (Backer et al., 2015, 2010; Stewart et al., 2006). Studies on recreational water users have shown that toxins from cyanoHABs are detectable in the air and measurable in personal air samplers, and that these toxins could be directly responsible for respiratory irritation (Backer et al., 2008, 2010). Respiratory irritation, however, is also associated with gases and vapors (e.g., hydrogen sulfide, methane) released as blooms die off, and these chemicals could be responsible for the reported respiratory effects from cyanoHABs. Studies are underway to better understand the health effects from aerosolized cyanoHABs.

Few gastrointestinal (GI) events were recorded during the time an HAB exposure code was used. Past reports of GI events and outbreaks, however, have been associated with HAB exposure (Backer et al., 2008; McCarty et al., 2016). In a prospective study of acute health effects, Lévesque et al. (2014) found that only GI symptoms were associated with recreational exposure to cyanoHABs. The study also found that higher cell counts of cyanobacteria were associated with an increase in the relative risk for GI symptoms. In 2014, a large microcystin HAB bloom occurred on Lake Erie, contaminating municipal drinking water and causing a do-not-drink advisory for over 400,000 people. A community assessment during this event found that the contamination was associated with a variety of health symptoms primarily related to GI distress such as nausea, vomiting, abdominal pain, and diarrhea (McCarty et al., 2016). Although the MarketScan data reported few GI events in the East North Central and Middle Atlantic regions that include Lake Erie and surrounding states, during 2014, most of the HAB-exposure codes (41%) were recorded within these regions.

These results likely represent only a subset of people who have symptoms or illnesses caused by HAB exposure because the data are a subsample from EHRs across the U.S. In addition, it is possible that only those with more severe symptoms are likely to visit a medical provider for treatment. During the 2014 microcystin water contamination in Ohio, most people who reported health symptoms during the do-not-drink water advisory (89%) indicated that their health issues were not serious enough to seek medical attention (McCarty et al., 2016). People also might not report HAB exposure to their healthcare provider or know to mention it during their medical visit.

While the findings from this data set are enlightening, limitations within the data set made us unable to verify that we had correctly classified people with HAB exposure codes. First, an exploration of the proximate events that occurred on the same day as the HAB exposure codes showed several conditions that would be unrelated to HAB exposure such as "diabetes mellitus without mention of complication," "tobacco use disorder," or "routine gynecological examination." It is likely these codes were used to describe the patient's status overall; however, it is unclear whether these codes were related to the symptoms presented at the medical visit. Several people also had a diagnostic code for fever, which, while unexpected based on what we know about HAB toxin exposure, should be explored further.

Second, several codes were used to describe injuries or lacerations, which could be unrelated to an actual HAB exposure. In addition, other codes sometimes were used that corresponded to potentially different exposures or indicated that the person might have been exposed to multiple substances: "Contact with and exposure to other hazardous aromatic compounds" or "contact with and exposure to other potentially hazardous chemicals." While these other exposure codes might be related to an HAB exposure event, it is unclear if these codes were indicative of the HAB exposure itself or another substance in the environment at the same time as the HAB event condition. Finally, because we were able to search only through records with ICD codes, we might have missed patients whose exposure to an HAB was documented elsewhere in the record.

Despite these limitations, exploring large scale EHR systems—and in particular those such as MarketScan that have primary care medical visits documented along with hospital visits—can help researchers estimate the occurrence of HAB-related illness across the U.S. Defining HAB exposure and related illness can be challenging because of misdiagnoses, failure of the patient fully disclosing exposures they might have had leading up to the health events (either because they fail to see the importance of the connection or fail to remember), or lack of general knowledge about HAB-related illness or use of HAB exposure codes by healthcare professionals.

As the symptoms associated with HABs are common among other illnesses and disorders, it is important to have exposure diagnostic code classifications to differentiate HAB-related illness from other exposures. Our findings can inform future medical education on the importance of using specific ICD codes for HAB exposures. Patients should also be encouraged to tell their physicians about their environmental exposures, specifically when HABs are present. Once there is increased knowledge by healthcare professionals regarding environmental exposures such as HABs, EHR databases will be much more useful for tracking environmental exposures and associated health effects.

Conclusion

In this initial evaluation of the MarketScan databases, we found that although HAB exposure codes were used infrequently, they were most often recorded during bloom seasons in warmer months. The most common health outcomes associated with these codes were respiratory symptoms. These findings suggest that EHR databases, though far from perfect, can be useful in examining trends in HAB-related illness reports in the U.S.

Disclaimer: The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention or U.S. Department of Health and Human Services. The article has not been revised or edited to conform to agency standards.

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continued on page 14

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Did You Know?

NEHA has released its 2020 Annual Report. The report highlights the milestones and successes of the association in 2020 with a focus on capacity building, resources and partnerships, membership, and finances. Read for full report at www.neha.org/about-neha/neha-annual-reports.

JEH QUIZ

FEATURED ARTICLE QUIZ #6

Evaluation of Electronic Health Records to Monitor Illness From Harmful Algal Bloom Exposure in the United States

Available to those with an active National Environmental Health Association (NEHA) membership, the *JEH* Quiz is offered six times per calendar year and is an easily accessible way to earn continuing education (CE) contact hours toward maintaining a NEHA credential. Each quiz is worth 1.0 CE.

Completing quizzes is now based on the honor system and should be self-reported by the credential holder. Quizzes published only during your current credential cycle are eligible for CE credit. Please keep a copy of each completed quiz for your records. CE credit will post to your account within three business days.

Paper or electronic quiz submissions will no longer be collected by NEHA staff.

INSTRUCTIONS TO SELF-REPORT A *JEH* QUIZ FOR CE CREDIT

1. Read the featured article and select the correct answer to each *JEH* Quiz question.
2. Log in to your MyNEHA account at https://neha.users.membersuite.com/home.
3. Click on Credentials located at the top of the page.
4. Select Report CEs from the drop-down menu.
5. Enter the date you finished the quiz in the Date Attended field.
6. Enter 1.0 in the Length of Course in Hours field.
7. In the Description field, enter the activity as "*JEH* Quiz #, Month Year" (e.g., *JEH* Quiz 6, May 2021).
8. Click the Create button.

JEH Quiz #4 Answers

January/February 2021

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

➔ Quiz effective date: May 1, 2021 | Quiz deadline: August 1, 2021

1. Short-term health effects have been associated with harmful algal bloom (HAB) exposure to algal toxins through
   a. skin contact.
   b. ingestion.
   c. inhalation.
   d. all the above.
   e. none of the above.
2. Health effects include respiratory illness, gastrointestinal illness, skin and eye irritation, and sometimes more severe toxic effects such as liver failure or paralysis.
   a. True.
   b. False.
3. The purpose of this study was to evaluate the use of International Classification of Diseases (ICD) medical diagnostic codes for HAB exposure across the U.S. using a large, de-identified electronic health records database.
   a. True.
   b. False.
4. For this analysis, the authors selected the two most recent data sets within MarketScan for Commercial and Medicaid claims. The most recent Commercial data set was available for approximately __ million people and the most recent Medicaid data set was available for approximately __ million people.
   a. 23; 90
   b. 23; 60
   c. 90; 23
   d. 90; 60
5. A total of __ records contained one of the HAB exposure codes.
   a. 122
   b. 178
   c. 380
   d. 558
6. Within the two databases, __ records were coded using the ICD-9 classifications while __ were coded using the ICD-10 classifications.
   a. 178; 380
   b. 192; 366
   c. 366; 192
   d. 366; 558
7. Within both cohorts, __ people had a hospital inpatient or emergency department visit on the same day in which the HAB exposure code was used.
   a. 122
   b. 144
   c. 178
   d. 192
8. Overall, __ were the years with the most use of HAB exposure codes.
   a. 2012 and 2015
   b. 2013 and 2016
   c. 2014 and 2018
   d. 2015 and 2017
9. More HAB exposure code records occurred during the fall and winter months (October–March).
   a. True.
   b. False.
10. When combining cohorts, approximately __ of individuals had respiratory events recorded on the same day an HAB code was used for them.
    a. 5.7%
    b. 10.9%
    c. 11.8%
    d. 37.1%
11. Of the records in the Medicaid database with HAB exposure codes, __ were for children and teenagers under the age of 18.
    a. 42%
    b. 52%
    c. 62%
    d. 72%
12. During the 2014 microcystin water contamination in Ohio, __ of people who reported health symptoms during the do-not-drink water advisory indicated that their health issues were not serious enough to seek medical attention.
    a. 50%
    b. 69%
    c. 75%
    d. 89%

INTERNATIONAL PERSPECTIVES/SPECIAL REPORT

Health Risks Associated With the Use of Water Mist Systems as a Cooling Intervention in Public Places in Australia

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Abstract **The exposure of people to opportunistic premise plumbing pathogens (OPPPs) such as *Legionella*, *Mycobacterium*, and *Pseudomonas* in aerosolized water has been linked to opportunistic infections. Water mist systems (WMS) that are used to cool public places by flash evaporation of tiny water aerosols are gaining prominence in regions with hot climates in Australia. The potential of WMS to be colonized by OPPPs has not been adequately studied. The public health impact of OPPPs is significant, as *Legionella* accounted for 66% of waterborne disease outbreaks associated with drinking water systems in the U.S. in 2013–2014. *Legionella* infections caused by the inhalation of contaminated water aerosols in Europe increased from 1,161/year in 1994 to 4,546/year in 2004. As WMS are part of premise plumbing, they have structural characteristics that promote biofilm formation, growth of free-living amebae, inadequate disinfection levels, elevated water temperatures, and oligotrophic conditions—all of which promote OPPP inhabitancy. This special report highlights the potential public health risks of using WMS as a cooling intervention in public places and advocates for their regulation in places of public assembly and entertainment.**

Introduction

Water mist systems (WMS) are defined as plumbing mechanisms installed in outdoor public places to reduce ambient temperatures. Small nozzles fitted to WMS atomize water into tiny aerosols that flash evaporate in the ambient atmosphere, reducing surrounding temperatures by as much as 10 °C. These WMS are more energy efficient than conventional air conditioning systems (Wong & Chong, 2010). Premise plumbing promotes the colonization and regrowth of opportunistic premise plumbing pathogens (OPPPs), including *Legionella pneumophila*, *Mycobacterium avium*, *Pseudomonas aeruginosa*, *Acanthamoeba*, and *Naegleria fowleri* (Falkinham, 2015; Whiley et al., 2014). These OPPPs cause opportunistic infections in children, older adults, and people with compromised immunity (Falkinham, Hilborn, et al., 2015).

Most of the research on WMS has been experimental, focusing on design capabilities and the operational efficiency of the systems (Wong & Chong, 2010; Xuan et al., 2012). Research on premise plumbing installations such as showers, water taps, and faucets, however, has confirmed the presence of *L. pneumophila*, *M. avium*, *P. aeruginosa*, *Acanthamoeba*, and *N. fowleri* (Falkinham, Hilborn, et al., 2015; Whiley et al., 2014). This special report examines and describes the OPPP risks associated with WMS systems in the Pilbara region of Western Australia. This region experiences extreme temperatures and has a higher use of WMS. We highlight the five major OPPPs implicated in waterborne diseases: *L. pneumophila*, *M. avium*, *P. aeruginosa*, *Acanthamoeba*, and *N. fowleri*.

Most WMS are located outdoors where they are exposed to elevated temperatures. Operation of WMS in these environmental conditions increases the water temperatures to levels at which OPPPs such as *L. pneumophila* thrive (Lu et al., 2017). The densities of *Legionella* and *Mycobacterium* species can increase with elevated water temperatures of 25–40 °C in showers and water taps (Lu et al., 2017). WMS located outdoors that are exposed to elevated temperatures can be a risk for OPPPs.

The WMS used for cooling public places are made from materials such as polyvinyl chloride (PVC), polyethylene, nylon, or steel. The use of these plumbing materials can promote the regrowth of OPPPs (Wang, Masters, et al., 2012). These plumbing materials leach nutrients that promote biofilm formation on the internal surfaces of pipework and fittings (Rogers et al., 1994).

Water stagnation causes disinfectant decay in water systems, resulting in the regrowth of

OPPPs (Wang et al., 2013). When WMS are shut down during winter, there is potential for growth of OPPPs that can subsequently be aerosolized if the units are turned back on in summer without proper treatment. A whole life cycle treatment plan must include the winter shutdown period and incorporate controls to prevent generation of contaminated aerosols.

Opportunistic Premise Plumbing Pathogens

The use of WMS is an emerging public health concern (Falkinham, Pruden, & Edwards, 2015; Wang et al., 2013) because they represent a potential source of exposure to so-called "opportunistic pathogens" that can affect the health and well-being of exposed individuals, especially among those with predisposing risk factors (e.g., children, older adults, and people with compromised immunity) (Falkinham, Pruden, & Edwards, 2015). Key OPPPs associated with premise plumbing are *L. pneumophila*, *M. avium*, *P. aeruginosa*, *Acanthamoeba*, and *N. fowleri* (Bédard et al., 2016; Falkinham, Pruden, & Edwards, 2015).

Legionella pneumophila

L. pneumophila has been associated with several outbreaks of waterborne legionellosis in premise plumbing (Bennett et al., 2014; Cohn et al., 2015). The bacteria colonize cooling towers, warm water baths, water fountains, and showers. If disturbed, the bacterial can aerosolize and result in respiratory disease and even death of exposed persons (Kim et al., 2015). *L. pneumophila* can grow inside amebae (Liu et al., 2019), making it resistant to chlorine disinfection (Dupuy et al., 2011); it has also been isolated from household plumbing (Barna et al., 2016; Byrne et al., 2018).

Mycobacterium avium

M. avium belongs to a group of nontuberculous *Mycobacteria* (NTM) called *Mycobacterium avium* complex (MAC). This complex includes *M. avium* and *M. intracellulare*, which are found in aquatic environments and soil, and transmitted via inhalation, ingestion, or inoculation (Rijhumal & Chai, 2015). MAC causes various infections depending on the subspecies, route of infection, and the immune health of the exposed person (Whiley et al., 2012). In people who previously had no symptoms, MAC causes pulmonary and soft tissue infections in healthy individuals (Falkinham, 2016). *M. avium* can cause cervical lymphadenitis in young women (Reuss et al., 2017) and pulmonary diseases in people with HIV/AIDS (Falkinham, Hilborn, et al., 2015).

M. avium has been isolated from premise plumbing and potable water systems (Water Research Australia, 2014; Whiley et al., 2012), hospital plumbing (Baird et al., 2011), and household plumbing (Falkinham et al., 2008). This ability of the bacterium to grow at temperatures >45 °C, paired with its chlorine resistance, enables it to thrive in water distribution systems (Falkinham et al., 2008). *M. avium* can colonize showerheads (Feazel et al., 2009), water taps, and water heaters (Wang, Edwards, et al., 2012), and subsequently be transmitted by the inhalation of contaminated aerosols (Falkinham, 2013). Like *L. pneumomphila*, *M. avium* can resist disinfection in premise plumbing by inhabiting amebae (Steed & Falkinham, 2006). WMS in public places mimic showers in terms of elevated temperatures (Feazel et al., 2009; Lu et al., 2017), plumbing materials, and potential for aerosol formation (Steed & Falkinham, 2006), making them a health risk for exposure to *M. avium*.

Pseudomonas aeruginosa

P. aeruginosa is a versatile OPPP that can adapt and survive tough environmental conditions (Bédard et al., 2016). This bacterium favors moist environments and has low nutritional requirements because of its ability to metabolize different compounds (Yu et al., 2016). These properties enable *P. aeruginosa* to form biofilms with other microorganisms present in premise plumbing systems, which confer resistance to disinfectants such as chlorine dioxide and monochloramines (Masák et al., 2014).

Transmission of *P. aeruginosa* occurs through exposure to contaminated water by inhalation and immersion and can cause self-limiting ear and skin infections (Rossolini & Mantengoli, 2005); it can also cause aggressive pneumonia in immunocompromised persons such as those with cystic fibrosis (Falkinham, 2015). *P. aeruginosa* has been isolated from hospital water taps (Shareef & Mimi, 2008), as well as from showerheads and hydrotherapy pools (Caskey et al., 2018). The ubiquitous nature of this bacterium in the environment, its hardiness, and potential for biofilm-produced chlorine resistance (Zichichi et al., 2000) make *P. aeruginosa* a particular concern in relation to WMS with their generation of aerosols and popularity in licensed clubs frequented by older adults and potentially immunocompromised individuals.

Acanthamoeba

Acanthamoeba is a protozoan that lives in varied environments, such as environmental and drinking water systems (Michel et al., 1998), tap and well water (Marciano-Cabral et al., 2010), hospital waters (Muchesa et al., 2015), aquatic facilities (Chang et al., 2010), and recycled water (Storey & Kaucner, 2009). *Acanthamoeba* is the causative agent of granulomatous amebic encephalitis (GAE), a central nervous system disease that affects people with weakened immunity. The species *Acanthamoeba* keratitis can also cause infection of the corneal epithelium (Pruden et al., 2013). The microorganism can grow in domestic tap water (Codony et al., 2012) and has been isolated from hospital water supplies (Muchesa et al., 2015). A significant characteristic of this OPPP is its ability to engulf and shield other OPPPs such as *L. pneumophila*, *P. aeruginosa*, and *M. avium* from disinfection (Zbikowska et al., 2014), which makes it an essential target for WMS infection control strategies.

Naegleria fowleri

N. fowleri, the only pathogenic species of its genus, causes fatal primary amebic meningoencephalitis (PAM). This infectious disease is transmitted by aspiration of contaminated water aerosols up the nasal passage (Yoder et al., 2012). This ameba can live in premise plumbing, rainwater tanks, and any system where warm water is present (Waso et al., 2018). The warm operational temperatures of WMS, coupled with their generation of inhalable water aerosols, make them a possible source of this rare but fatal infection.

Public Health Impact

The public health risk of OPPPs and their associated infectious diseases are significant. WMS create thermal comfort by atomizing water into aerosols. The aerosols range from 0.3–10 µm and can be deposited into the lungs by inhalation, where they can cause infections (Henningson & Ahlberg, 1994). The OPPPs range from 2–20 µm for *L. pneumophila* (Füchslin et al., 2010), 0.2–0.6 µm for *M. avium* (Vijay et al., 2017), 0.5–1.0 µm for *P. aeruginosa* (Deforet et al., 2015), 12–35 µm for *Acanthamoeba* (Siddiqui & Khan, 2012), and 15–20 µm for *N. fowleri* (Piñero et al., 2019). Most of these OPPPs fall within the size fraction that are inhalable by people; or, they can land on skin and surfaces, creating another potential exposure route. They can also be ingested and cause skin irritation.

Legionella alone is responsible for 2–15% of patients hospitalized globally with community-acquired pneumonia (Sakamoto, 2015). In the U.S., 32 cases of waterborne disease outbreaks were reported between 2011 and 2012, with 66% of the outbreaks being associated with *L. pneumophila* (Beer et al., 2015). The incidence rate for waterborne *M. avium* disease over the same period was 647 cases/100,000 persons (Beer et al., 2015).

In Australia, an average of 374 cases of legionellosis were reported annually between 2008 and 2018 (Australian Government Department of Health, 2021), with an incidence rate of 1.50/100,000 persons in 2015, dropping to 1.2/100,000 in 2019. The combined mandatory reporting of *L. pneumophila* and *L. longbeachae* infections as legionellosis cases in Australia does not provide specific information about the incidence of infections caused by different *Legionella* species. This lack of specificity obscures any trends associated with exposure routes, considering that one is soilborne (*L. longbeachae*) and the other is waterborne (*L. pneumophila*).

A total of 143 cases of PAM were reported across the U.S. between 1962 and 2017 (Centers for Disease Control and Prevention, 2020). In Australia, 19 water-related PAM cases were recorded between 1960 and 1980. The case rate for microbial keratosis, a disease caused by *Acanthamoeba*, was 0.66 cases/10,000 between 2005 and 2015 (Waso et al., 2018). Opportunistic infections caused by *M. avium* and *P. aeruginosa* could be underestimated because they are not notifiable diseases in most countries (Falkinham, Hilborn, et al., 2015). NTM, however, are notifiable diseases in the Australian states of Queensland and the Northern Territory; PAM is a notifiable disease in Western Australia (Australian Government Department of Health, 2021). A total of 19 PAM cases were reported in Australia during 1965–1980 (Waso et al., 2018) and another 4 cases were reported in Queensland during 2006–2015 (Nicholls et al., 2016).

Factors That Promote Opportunistic Premise Plumbing Pathogen Colonization

Biofilm Formation

The potential of biofilm formation is a significant risk factor for the incidence of respiratory/infectious disease outbreaks associated with WMS. Biofilms are complex heterogeneous colonies consisting of bacteria, fungi, protists, and other microbial organisms that grow as native communities in water systems (Wingender & Flemming, 2011). Biofilms in premise plumbing systems provide conducive and nutritive conditions for OPPP growth, increase the potential for OPPP colonization, and inhibit disinfectants used to clean systems (Ashbolt, 2015; Falkinham, 2015; Momba et al., 2000; Pruden et al., 2013; Wang et al., 2013).

In drinking water systems, 95% of the microbiological population resides in biofilms compared with approximately 5% in the water phase (Flemming et al., 2002). The OPPPs residing in biofilms of water systems, however, can be released into the water phase where they can cause waterborne diseases (Flemming, 2011). Biofilm formation can occur as a result of extreme environmental conditions of temperature, pH, and pressure (Momba et al., 2000). Maintenance programs aimed at minimizing potential for their generation are essential. Sampling and analysis of biofilm samples from WMS used for cooling are recommended to provide an insight into their potential as sources of OPPPs.

Temperature

Elevated water temperatures in distribution systems promote the growth of OPPPs (Falkinham, 2015; Storey et al., 2004). The ability of microorganisms to survive at elevated water temperatures is an essential adaptation feature that enables *L. pneumophila*, *M. avium*, and *P. aeruginosa* to thrive in water systems (Falkinham, Pruden, & Edwards, 2015). The WMS used for cooling public places are exposed to high temperatures that can promote the regrowth of OPPPs (Storey & Kaucner, 2009). It is necessary to determine the water temperature profile of WMS to understand its influence on OPPP regrowth.

Presence of Free-Living Ameba

The presence of ameba in premise plumbing can aid the regrowth of OPPPs (Wang, 2013; Wang et al., 2013). The ability of free-living ameba to amplify the number and virulence of OPPPs in engineered water systems is widely acknowledged (Falkinham, 2015; Thomas & Ashbolt, 2011). WMS used in public places need to be investigated for free-living amebae, particularly *Acanthamoeba*, due to their virulence in water distribution systems and their role in the regrowth and amplification of OPPPs (Codony et al., 2012).

Resistance to Chlorine Disinfection

Chlorine is an effective water disinfectant and remains one of the most important public health interventions (Boorman, 1999; Government of Western Australia Department of Health, 2016). At the right pH (6.5–8.5), temperature (20–29 °C), and turbidity, chlorine provides an adequate residual disinfectant effect (Australian Government National Health and Medical Research Council, 2011). Under specific environmental conditions, however, OPPPs can become resistant to chlorine and its derivatives, especially when part of a biofilm colony (Canals et al., 2015; Codony et al., 2012).

Most WMS are connected to water treated at conventional water treatment plants; however, WMS located in remote parts of the region can use on-site borehole water supplies that are locally managed. Chlorination is the most common means of disinfection for Australian water supplies, with a minimum target of 0.5 mg/L residual chlorine recommended (Australian Governnment National Health and Medical Research Council, 2011). As chlorination is the main form of disinfection for water supplies connected to WMS, an investigation of its effectiveness in controlling the regrowth of OPPPs in these systems is warranted.

Low Total Organic Carbon Concentration Levels

OPPPs can thrive in premise plumbing systems with low carbon concentrations (Falkinham, Pruden, & Edwards, 2015). Low-carbon or oligotrophic environments are characteristic of most premise plumbing

(Wang et al., 2013). The nitrifying bacterial autotrophs present in low-carbon waters fix available carbon, making it available to heterotrophic organisms such as OPPPs to metabolize (Wang et al., 2013; Zhang & Edwards, 2009). Through this process, low-carbon water environments existing in WMS can select for *L. pneumophila* (van der Kooij et al., 2005), *P. aeruginosa* (Bédard et al., 2016), and *M. avium* (Falkinham, Pruden, & Edwards, 2015). To better understand the impact of oligotrophic conditions on the ability of OPPPs to colonize and regrow in WMS, analysis of water samples from these systems for total organic carbon concentration levels is needed.

Other Control Methods for Opportunistic Premise Plumbing Pathogens

The resistance to disinfection presents significant challenges in using traditional approaches to control OPPPs (Falkinham, Pruden, & Edwards, 2015); therefore, alternative control approaches for OPPPs in premise plumbing are needed. Control of OPPPs in water can be achieved by reducing turbidity (Falkinham, 2015). Additionally, regular cleaning and disinfecting of nozzles can be an effective way of controlling OPPPs (American National Standards Institute, 2018; Health and Safety Executive, 2014). The installation of microbiological filters to WMS can control OPPPs (National Research Council, 2006). Like most bacteria, *L. pneumophila* and *P. aeruginosa* are susceptible to UV irradiation and thus can be controlled in premise plumbing by this method (Falkinham, 2015; Leoni et al., 2015), but it has been noted that high turbidity inhibits disinfection. The introduction of nonpathogenic protozoa species that target OPPPs can achieve a probiotic control of OPPPs in WMS (Wang et al., 2013). The addition of silver ions at a concentration of 40 µg/L has a bactericidal effect on *L. pneumophila* and many other microorganisms in plumbing systems without affecting humans, making silver ions suitable for controlling OPPPs in WMS (Fewtrell, 2014).

Conclusion

The use WMS as a cooling intervention in public places should be considered a potential public health risk due to the potential for poorly managed systems to release inhalable aerosols contaminated with microbes. These aerosols could contain pathogenic organisms, referred to as OPPPs, such as *L. pneumophila*, *M. avium*, *P. aeruginosa*, *Acanthamoeba*, and *N. fowleri*. In addition to inhalation, the aerosolization of contaminated water in WMS can result in microbial deposition on skin, food, and other surfaces, resulting in a localized reaction (e.g., to skin or eyes) or ingestion. An investigation of the health risks associated with the use of WMS as a cooling intervention is warranted to better understand the public health impact and inform strategies to manage WMS.

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continued on page 20

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continued on page 22

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SPECIAL REPORT

Use of an Environmental Swabbing Strategy to Support a Suspected Norovirus Outbreak Investigation at a Retail Food Establishment

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Abstract **The public health burden related to norovirus is well described as the leading cause of foodborne outbreaks in the U.S. Norovirus investigations present challenges due to low infectious dose, multiple transmission routes, and the rapid onset and resolution of symptoms. Environmental sampling for norovirus can provide valuable data during public health investigations and lead to targeted education and interventions. In some instances, environmental data could be accessible when other data sources are limited or difficult to collect. We describe use of an environmental sampling strategy during a foodborne outbreak investigation to support the hypothesis for transmission from an ill food worker to restaurant patrons.**

Introduction

Norovirus is a significant public health burden and a leading cause of foodborne illness in the U.S., accounting for approximately 60% of food-related illnesses (Scallan et al., 2011). In the U.S., it is estimated that norovirus causes 570–800 deaths, 56,000–71,000 hospitalizations, and 19–21 million total illnesses per year (Hall et al., 2013). The burden of norovirus is difficult to estimate due to the absence of national case reporting, limited commercial clinical assays in the U.S., and the fact that only a small percentage of individuals seek medical attention and have testing performed (Yen & Hall, 2013). These challenges in sporadic disease surveillance underscore the importance of norovirus investigations and characterization during outbreaks. Outbreaks can best be investigated and characterized by integrating the disciplines of environmental health, laboratory, and epidemiology using a variety of tools, including environmental sampling.

Even when norovirus outbreaks are thoroughly investigated, investigations sometimes are inadequate to determine etiology and mode of transmission. Challenges can include unwillingness of exposed persons to be interviewed, reluctance of symptomatic people to provide a stool sample, too small of a sample size for statistical analyses, and poor food history recall. Environmental sampling for norovirus is an approach that can aid in determining transmission routes and informing short- and long-term control measures during outbreaks.

We report on a December 2016 norovirus outbreak investigation during which environmental sampling was an important source of data for action because of limitations in the collection of epidemiological and clinical laboratory data.

Methods

The Tennessee Department of Health conducts active complaint-based outbreak surveillance. Outbreak investigation methods were implemented jointly by the Metro Public Health Department of Nashville/Davidson County and the Tennessee Department of Health. Investigational methods included an online questionnaire, collection of clinical specimens, environmental assessment, and environmental swabbing.

An online questionnaire was developed to collect food histories; clinical specimens were collected from ill patrons. Tennessee Department of Health Public Health Laboratory protocols were followed for environmental sample collection including communication, sample transportation, chain of custody, and sample handling guidelines. The sampling strategy and materials for environmental swabbing were based on investigational findings, interviews, environmental assessment, and a priori risk-based sampling that included high-touch surfaces and restrooms (Huslage et al., 2010; Park et al., 2015; Wadl et al., 2010; Wu et al., 2005). A preassembled outbreak sampling kit was deployed containing 50 EnviroMax Plus 6-in. sterile round macrofoam swabs, 4 large sealable freezer bags, a chain of custody form, disposable gloves, permanent markers for numbering swabs, a clipboard, head covers, and an insulated cooler with ice for sample transport.

For targeted flat surfaces, vertical, horizontal, and diagonal S-strokes were made that captured an estimated 25–100 cm^2 of surface area. When shifting from the vertical stroke to the horizontal stroke, the swab was rotated to the opposite side and then kept on that side for the diagonal stroke. Irregular surfaces were swabbed with a back-and-forth swiping motion using both sides of the swab. Sample vials were recorded per chain of custody protocol and delivered within 1 hr of collection. Surfaces targeted for sample collection were based on employee and customer interviews, observations during the environmental assessment, and previous norovirus studies (Huslage et al., 2010; Park et al., 2015; Wadl et al., 2010; Wu et al., 2005).

Briefly, DNA was extracted from the swabs and a norovirus multiplex (TaqMan) reverse transcription, real-time polymerase chain reaction (RT-qPCR) assay was performed. DNA extraction was performed by adding 1.0 ml of molecular grade water to each swab container, which was then vortexed for 7–8 s with the swab attached. After being vortexed, 150 µl of each swab sample was used to perform an automated extraction using the Roche Pure LC 2.0 Total Nucleic Acid Kit on a Roche MagNA Pure LC 2.0 instrument. A total of 5 µl of extract was used to perform RT-PCR to detect norovirus (genotype GI or GII).

Results

The Metro Public Health Department of Nashville/Davidson County responded to a complaint of several individuals who reported gastroenteritis following a meal at a restaurant. This cluster was comprised of individuals from a group attending a private dinner party. Onset of illness and symptoms were consistent with exposure to norovirus at the dinner party (Hall & Lopman, 2014). The implicated establishment was a full-service restaurant consisting of two separate buildings: one larger building with a main kitchen, dining area, and public restrooms and one smaller building with a private dining area, restrooms, and auxiliary kitchen. Foods served to the private party were prepared in both the main and smaller buildings. Restaurant employees were not limited to a single building; however, members of the private party did not have access to the larger building or its restrooms.

A total of 10 cases were identified in people who had reported gastrointestinal illness from the private dining party on December 16, 2016; of these cases, 8 were male (80%) and 2 were female (20%). The median reported incubation period was 24 hr and median illness duration was 28 hr. No single food item was found to be statistically significant in the cohort analysis.

Stool samples collected from four ill individuals tested positive for norovirus GII.2. Environmental sampling locations included the auxiliary kitchen, private dining area, and restrooms. Emphasis for sampling was placed on high-touch surfaces (63%, n = 15) and restrooms (63%, n = 15). Of the 24 swabs, 2 (8%) were positive for norovirus GII.2. The positive samples were recovered from a toilet located in the unisex restroom in the main building. All samples recovered from the restroom used exclusively by the private dining party were negative.

A detailed environmental assessment was conducted on December 20, 2016. During the assessment, a food worker was identified as being ill at work on the implicated meal date of December 16, 2016. The employee reported having diarrhea in the unisex restroom located in the main building. The environmental assessment further ascertained that the ill employee's duties included working with food served to the individuals in the private party. An unsuccessful attempt was made to collect a stool sample from the ill food handler.

Discussion

Foodborne outbreak investigations are complex and result when more than one thing goes wrong (Bryan, 1978). Comprehensive investigation is dependent on a collaborative approach that includes environmental, epidemiological, and laboratory data. While laboratory data can assist in confirmation of the etiology, implicate temporal transmission events, and suggest control measures, specimens and samples can be difficult to obtain. This difficulty is particularly true for norovirus due to the characteristic quick recovery of ill individuals. There are numerous examples of very large norovirus outbreaks with few or no clinical specimens collected. Furthermore, due to time gaps between exposure and outbreak identification, implicated foods might not be available to collect and test. Food is difficult to test for norovirus, with few validated methods available (with the exception being shellfish). During this outbreak investigation, we found environmental swabbing to be strongly supportive in implicating the ill food handler hypothesis. This approach helped to overcome limitations in the epidemiological approach.

The environmental sampling techniques and materials used were based on methods for environmental isolation of norovirus described by Park et al. (2015). The environmental sampling protocol for norovirus used during this investigation was developed in collaboration with the state public health laboratory. Discussions and protocols regarding sampling supplies, methodology, and communications had been agreed upon prior to the outbreak investigation. During the investigation, communications with the laboratory regarding current capacity assisted in sample size selection and priority areas for sampling. We used 24 swabs, selecting areas and surfaces based on epidemiological and environmental assessment data. We focused on areas where the ill food worker reportedly was present, with a special focus on restrooms and food preparation areas used by this employee. Other sampling locations included the restrooms and high-touch surfaces of both buildings.

Our investigation successfully confirmed the outbreak etiology through collection of stool specimens from ill customers. The mode of exposure and suspect vehicles of transmission, however, were difficult to determine definitively using routine epidemiology methods. Active case finding among patrons outside of the private dining party presented challenges and was unsuccessful.

Due to the small sample size in the cohort analysis, epidemiological results were inconclusive. During this investigation, the positive environmental samples collected from the toilet used by the ill employee who had diarrhea matched the genotype of norovirus found in stool specimens among cases from the dining party. All samples taken from the restroom located in the private dining building were negative. The environmental sampling result supported our hypothesis that the ill worker, who we were unable to collect a stool specimen from, was the source of exposure to the dining party.

Opportunities for improvement on how to properly implement a policy for ill worker reporting and exclusion were also identified during the environmental assessment. While an ill worker reporting policy existed within the firm, employees were not well trained and/or were not following the written policy. No additional contributing factors to the outbreak were identified.

Limitations

A number of limitations were apparent in this investigation. The specific strain of norovirus recovered from both stool cultures and environmental samples was common. The Centers for Disease Control and Prevention's CaliciNet reporting and surveillance data indicate that approximately 20% of the norovirus outbreaks from September 1, 2016, to August 31, 2017, were genotype GII.2 (Centers for Disease Control and Prevention, 2017). It is possible that norovirus GII.2 isolated from the toilet was not from the ill employee.

Another limitation was that environmental sampling occurred 4 days after the exposure event, meaning that restaurant employees had performed multiple routine sanitizing and disinfecting procedures before samples were taken. Sanitizing systems in the restaurant were found in compliance during the environmental assessment, so other areas of contamination might not have been detectable despite sampling.

Lastly, we collected only 24 swabs covering a small fraction of the total surface area potentially contaminated by the ill food handler. Although we used a priori knowledge and targeted sampling to previously identify high-risk, high-touch areas, an element of chance exists in hunting for norovirus in the environment.

Conclusion

This investigation highlights the benefit of environmental swabbing and testing for norovirus during an outbreak, which we found to be an important adjunct source of data in this outbreak—especially with limitations in the ability to collect robust epidemiological data. Environmental sampling identified additional areas where employees might have been at risk for norovirus transmission and potentially limited further spread with recommendations for targeted effective control and sanitization.

As a result of the environmental sample findings, we made specific recommendations to management including adherence to ill worker policies, response strategies to mitigate outbreaks, and targeted disinfection methods. Development of additional illness reporting policies and employee training within the restaurant were required as a result of the investigation and environmental sampling. Public health jurisdictions should consider using environmental sampling during selected outbreaks to support their investigation and implementation of control measures.

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DIRECT FROM AAS

Students, Prospective and Novice Environmental Health Professionals: You Must Attend This Virtual Conference!

Brian Collins, MS, REHS, DAAS

Editor's Note: In an effort to provide environmental health professionals with relevant information and tools to further the profession, their careers, and themselves, the National Environmental Health Association 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 the column, information from different AAS members who are subject-matter expects 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.

Brian Collins is the chair of AAS, a past president of NEHA, former director of environmental health, and a registered environmental health specialist for over 30 years.

Sanitarians and environmental health professionals are expected to competently and scientifically anticipate, recognize, evaluate, prevent, and mitigate risks that pose threats to humans and the environment. As a student or a prospective or novice environmental health professional, it is important to learn and be aware of trends in population health, the environment, business, and technology related to the practice. Overarching these trends, and especially in the era of social distancing and COVID-19, it is critical to connect or reconnect with the practice of environmental health and the people within the profession. The most efficient method by which professionals can optimize time, opportunity, learning, expense, and return on investment in achieving competence is through attendance at professional conferences.

The advent of virtual conferencing creates an efficient method for students, prospective professionals, novice professionals, and tenured professionals to optimize time, opportunity, learning, expense, and return on investment in achieving competencies. The American Academy of Sanitarians (AAS) endorses the National Environmental Health Association (NEHA) 2021 Annual Educational Conference (AEC) & Exhibition Three-Part Virtual Series as an ideal opportunity to learn, network, enhance professional competencies and create vertical career opportunity.

Virtual professional conferences offer:

- **Education:** Receive training, coaching, and mentoring from experts and industry professionals that are current and relevant. Professional continuing education units are a bonus!
- **Relevance:** Hear about new ideas, methods, and technologies. Ask questions, seek feedback, share, contribute, and grow.
- **Inspiration:** Learn and interact with celebrity environmental health professionals, experts, mentors, coaches, vendors, and cohorts. Enthusiasm and passion are contagious!
- **Motivation:** Learn what others have done, or in some cases not done, that led to success or enabled them to avoid pitfalls. Meeting with high achievers makes one realize you have the same potential. It can be transformational!
- **Exhibition:** Exhibitors introduce new technologies, products, software applications, and educational materials.
- **$$$$:** Conference attendees are more likely than nonattendees to advance their careers and make more money. Enough said!

The NEHA 2021 AEC Virtual Series will be held in three parts and is bound by the theme, "Together a Safer and Healthier Tomorrow." Dates for the conference series are April 20–21, June 1–2, and July 14–15. Diplomates of AAS will participate in various live sessions with question and answer opportunities and interactive polls; networking (individually and in forums), breakout sessions, and in the virtual exhibition. AAS is also working with NEHA to provide student sessions, coaching and mentoring opportunities, career advisement to novice environmental health professionals, and serve as ambassadors at the NEHA 2021 AEC Virtual Series. And finally, AAS will concurrently hold its second virtual Annual Business Meeting and General Membership Meeting on July 13.

Empirically, it used to be that people who have more knowledge command and acquire the most success and influence. AAS Diplomates have learned that people with the greatest ability to *connect* knowledge and people acquire and command the most success and influence. By extension, this virtual conference provides students, prospective professionals, and novice professionals an interactive, cost-efficient nexus for learning, networking, competency, success, and influence. Opportunity is presented that can build a path to being one of those who can connect knowledge with people to enhance the practice and profession of environmental health.

Please visit www.neha.org/aec for NEHA 2021 AEC Virtual Series general information, dates, registration information, session topics, and the schedule of events. Consider the return on investment extended with the great conference rates (the student registration fee for all sessions is just $95).

Final thoughts: You must attend this virtual conference! Success comes with not only who you know but also who knows you!

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2021 Model Aquatic Health Code (4th Edition)

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Editor's Note: The National Environmental Health Association (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, NEHA features this column on environmental health services from the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In these columns, authors from CDC's Water, Food, and Environmental Health Services Branch, as well as guest authors, will share insights and information about environmental health programs, trends, issues, and resources. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of CDC.

Michele Hlavsa is chief of the Healthy Swimming Program in CDC's National Center for Emerging and Zoonotic Infectious Diseases (NCEZID). CDR Joseph Laco serves as an environmental health officer at CDC's National Center for Environmental Health. Vincent Hill is chief of the Waterborne Disease Prevention Branch in CDC's NCEZID. Pieter Sheehan serves as board president of the Council for the Model Aquatic Health Code and is the director of environmental health at Fairfax County Health Department in Virginia.

The Centers for Disease Control and Prevention (CDC) will be releasing the 4th edition of the Model Aquatic Health Code (MAHC, www.cdc.gov/mahc) in the coming months. The MAHC represents a collaboration among local, state, and federal public health officials, particularly environmental health practitioners, and representatives of the aquatics sector to optimize prevention of illness and injury associated with public aquatic venues (e.g., pools, hot tubs, and water playgrounds).

Thank you to those who submitted change requests (i.e., proposed MAHC revisions), and particularly to the Council for the Model Aquatic Health Code (CMAHC, www.cmahc.org) committees that submitted change requests reflecting committee consensus. Thank you to Dewey Case, CMAHC technical director, for the late nights and weekends spent supporting the CMAHC Technical Review Committee (TRC). And above all, thank you to Amanda Tarrier, principal sanitarian in the New York State Department of Health, for her leadership. As TRC chair, she led the committee in its evaluation of an unprecedented 530 change requests during the COVID-19 pandemic.

The following sections highlight substantial topics addressed by the change requests.

Cyanuric Acid

Cyanuric acid (CYA) binds to chlorine to prevent it from being degraded by UV light from the sun. Consequently, CYA increases the amount of time it takes for chlorine to inactivate pathogens. CYA is sold as a stand-alone product or as chlorinated isocyanurates (chlorine and CYA, commonly known as dichlor or trichlor). In 2015, CMAHC established a CYA ad hoc committee that included representatives from across the CYA industry and researchers but did not include state or local public health officials. CMAHC charged the committee to develop guidance on CYA concentrations.

The committee reanalyzed data in scientific, peer-reviewed articles that examined the effect of CYA on pathogen inactivation. The committee developed mathematical models that accounted for the rate of pathogen introduction into aquatic venue water, disinfection, transport, and pathogen uptake by swimmers to predict the associated risk of acute infectious gastrointestinal illness. Mathematical models are mathematical equations that aim to distill the relationship among factors within a system to predict an outcome. Potential factors include established science (e.g., concentration of chlorine needed to inactivate pathogens over time at set water pH and temperature), current practices (e.g., closing aquatic venues to swimmers at night), and real-world variability (e.g., the efficiency at which different filters remove pathogens).

Based on the original models, the committee recommended a maximum ratio of 20 ppm CYA:1 ppm DPD (N,N-diethyl-p-phenylenediamine) free available chlorine (Falk et al, 2019). This ratio was chosen based on the U.S. Environmental Protection Agency (2012) 36/1,000 annual risk of *Giardia* infection limit for untreated recreational waters (e.g., in lakes). The proposed definition of DPD free available chlorine includes cyanurate-bound available chlorine and hypochlorous acid and hypochlorite ions.

The committee subsequently refined its models, tweaking factors included in the model to better reflect the complexity of water chemistry and aquatic venue operation. These changes resulted in varying recommended CYA:DPD free available chlorine ratios—20:1 through 40:1—and explains, in part, why several CYA-related change requests were submitted.

One of the change requests approved by the CMAHC membership called for adding the following parameters to the list of MAHC violations requiring immediate correction or closure: >45 ppm CYA:1 ppm DPD free available chlorine or >300 ppm CYA. The proposed maximum 45:1 ratio is the de facto ratio in the 2018 MAHC, with the MAHC calling for CYA concentration to remain ≤90 ppm and for maintaining a minimum of 2 ppm chlorine when using CYA (Centers for Disease Control and Prevention, 2018). The proposed maximum 300 ppm CYA concentration is based on a toxicity report (Cox & Hamilton, 2019).

CDC foresees incremental CYA-related revisions to the 2021 MAHC (4th edition). Bringing state and local public health officials onto the committee, as well as additional research and development of best practices, will inform future incremental CYA-related revisions to the 2024 MAHC (5th edition) and subsequent editions.

Consistency Between the Model Aquatic Health Code and International Swimming Pool and Spa Code

The MAHC is an open access, science- and best practices-based model code that aims to protect public health through design, construction, operation, and maintenance. In 2018, CMAHC established a standing committee focused on maximizing consistency between the MAHC and the International Swimming Pool and Spa Code (ISPSC). This committee is charged with:

1. identifying inconsistencies between design criteria in the MAHC and ISPSC;
2. evaluating appropriate scientific, peer-reviewed articles (or in their absence, best practices); and
3. making recommendations accordingly for revisions to the MAHC, ISPSC, or both.

Chapter 5 (Operation and Maintenance) and Chapter 6 (Policies and Management) of the MAHC will likely be adopted into the ISPSC in 2024. Harmonizing the MAHC and ISPSC marks a big step toward establishing one set of aquatic venue and facility design, construction, operation, and management criteria across the U.S. A total of seven harmonization change requests, focused on a range of topics (e.g., use of computational fluid dynamics models and design of no diving markers), were approved by CMAHC membership. The remaining two harmonization change requests were approved by the CMAHC Board of Directors. A few inconsistencies remain unresolved and could be addressed in the next MAHC and ISPSC update cycles.

Novel Aquatic Venues

Three change requests each addressed the design, construction, operation, and management of one of three novel aquatic venues. The CMAHC TRC determined the artificial swimming lagoon change request and surf venue change request needed to be revised to clarify the text. The revised change requests will be resubmitted for the 2024 MAHC. Waiting 3 years to address artificial swimming lagoons and surf venues in the MAHC, however, doesn't immediately protect public health. Through a collaboration with state and local public health departments, the aquatics sector, and CMAHC, CDC will develop interim guidance. The change request addressing natural swimming pools defers to standards developed elsewhere. Consequently, the TRC recommended that CMAHC convene an ad hoc committee to evaluate if the MAHC should address natural swimming pools, and if so, how.

CMAHC has provided CDC with proposed revisions for the 2021 MAHC based on CMAHC membership approval, or in a few instances, CMAHC board approval. As CDC staff across three centers and three offices evaluate the revisions and finalize the 2021 MAHC, CDC and CMAHC set their sights on the 2024 MAHC.

Without the frontline healthy and safe swimming expertise of state and local environmental health practitioners, the MAHC cannot optimally prevent illness and injury. How can CDC and CMAHC support state and local public health official participation despite their limited resources being further strained by the COVID-19 pandemic? Part of the answer is the CMAHC State Designee Committee, a forum for tackling issues once as a public health cadre instead of many times over individually.

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DIRECT FROM ecoAmerica


Rebecca C. Rehr, MPH

Robert M. Perkowitz

Denial: Our Biggest Environmental Health Threat?

Editor's Note: The National Environmental Health Association (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 this column from ecoAmerica whose mission is to build public support and political resolve for climate solutions. NEHA is an official partner of ecoAmerica and works closely with their Climate for Health Program, a coalition of health leaders committed to caring for our climate to care for our health. The conclusions in this column are those of the author(s) and do not necessarily represent the official position of NEHA.

Rebecca Rehr is the director of ecoAmerica's Climate for Health Program and Robert Perkowitz is the founder and president of ecoAmerica.

We all recognize air and water pollution, certain ingredients in food or consumer products, vector-borne diseases, and many other issues as environmental health threats. People in the U.S. are also waking up to the fact that climate change and all its implications could be our biggest environmental health challenge. There's one important thing missing, though, from this list: the psychological condition of denial.

Denial, an extreme form of disagreement, is in fact an environmental health concern. Many of the subjects dominating our headlines over the last year—climate change, COVID-19, vaccines, election integrity—are great examples. People are given conflicting information or disinformation on various topics. They make their decisions on the basis of social identification and whatever they believe, and there probably exists a news source or discussion board that validates people's perspective. Science and facts typically ground one side of the dichotomies. The other might be grounded in disinformation, fear and emotion, or conflicting priorities and self-interest. If we are going to help our organizations and communities effectively manage environmental health threats, we need to be able to help them manage denial.

Understanding Denial

Humans are social beings. We live as part of and in cooperation with our communities. People are not born with biases—our views are shaped through life experiences and reinforced by our social groupings and communities. Then, once a perspective is absorbed and internalized, it is very difficult to change our mind especially if it goes against the grain of our social milieu (Kolbert, 2017). Nonconformity with community views could limit your career or acceptance in the community, as well as even result in ostracization.

We all got our news from the same few television stations and the same local newspapers just a few decades ago. Congress passed the Fairness Doctrine annually from 1949–1987 that required broadcasters to identify and express opinion separately from factual news. The advent of cable TV and the internet exploded news options. Instead of appealing to people in the U.S. more broadly, commercial media success often became grounded in targeting niches and reinforcing extremes. Indeed, the internet and social media have grown so quickly that they have outpaced the way our minds use reason to understand and digest facts and scenarios (Kolbert, 2017). Selecting one's own versions of the truth that might not be based in science and facts puts all of us at risk.

In this atmosphere it is easier to sow doubt than to prove something definitively. Science and facts evolve as we learn new information. Wearing masks to stop the spread of COVID-19 is a good example. Initially, we were not aware of the high number of asymptomatic carriers. Now we know that 40–45% of infected people can spread the virus without showing symptoms (Oran & Topol, 2020). We know wearing a mask slows the spread. Environmental health professionals need to stay current with science and ground themselves in facts to be effective in their work.

Some say we are in a postfact, posttruth era, but we are still surrounded by objective truth and reality. Wildfires, storms, and votes are real and impact our lives in profound ways. If the scientific explanation of these events conflicts with your interests or worldview, it is easier for most to find and seek solace in other validators than it is to change our mind. As with COVID-19, inconsistent messaging and amplification of falsehoods from people in power fed distrust and denial rather than united the country to defeat the virus.

Dealing With Denial

How can environmental health professionals deal with denial and support healthy practices when some, maybe many, of their stakeholders chose to believe concepts counter to public health? There is not necessarily a silver bullet to address these issues but rather an arsenal of communications resources and guidance to help.

- **Ground yourself in science and facts.**
  1. Research the topic and internalize the facts.
  2. Practice talking about it.
  3. Craft solutions and next steps.
- **Understand and adjust to the context.**
  1. Are you amidst other professionals seeking the best path forward for your organization or community? Openly share and seek best knowledge and practices. Make it real with simple, irrefutable facts (Krygsman & Speiser, 2016a, 2016b).
  2. Are you in a gathering where denial might be present? Focus on impacts, solutions, and benefits more than causes. Be respectful, acknowledge ambivalence, and show empathy (Krygsman & Speiser, 2016a). Cite examples everyone can agree on and sources that everyone can trust.
  3. Is it an email, opinion piece, or letter to the editor that merits a response? Use the same strategy as group gatherings but keep it brief and do not get into a debate. No need to refute or challenge, just make your points.

You can inspire and empower people to take action by focusing on things that everyone can see around them and the actual environmental health impacts, as well as providing solutions that are accessible now and showing the benefits of those solutions to your organization and community.

Combating Climate Denial to Improve Environmental Health

Climate science that emerged in the 1950s projected a warming future and ice sheets in the Arctic melting. It was all tomorrow's problem, but the decades of inaction since then have made climate change a very real present-day emergency. Vehement climate science denial is fading as people look out their windows to see extreme weather, fires, and associated health outcomes. Climate solutions, however, still face opposition in communities and with decision makers because of powerful forces that still sow seeds of doubt, division, and misinformation. A clear majority people in the U.S. (74%) report being concerned about climate change, including almost one half (45%) who are very concerned (Kobayashi, 2020). Some still deny, however, the threats climate change poses to their health and livelihoods.

Environmental health professionals can be major change agents in moving doubters from denial to climate solvers. People in the U.S. trust health professionals for information on climate change, but only 1 in 5 report hearing about climate change from health professionals (Kobayashi, 2019). We must help people understand they are not alone in their concern about climate change. We must also unite in our demand for climate solutions that can be implemented now (Hill, 2020).

The National Environmental Health Association (2020) is leading the charge with a new position statement on climate change and as a charter signatory of the MomentUs campaign (ecoAmerica, 2021). The cost of inaction has proven to be too high and with the economy still reeling from COVID-19 impacts, we have the opportunity to rebuild with a greener and more equitable framework that unites us.

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DIRECT FROM U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT

Delivering Science to Front Lines of a Disaster: How U.S. Environmental Protection Agency Researchers Assist With Environmental Emergency Response

Gregory Sayles, PhD

Editor's Note: The National Environmental Health Association (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, NEHA has partnered with the Office of Research and Development (ORD) within the U.S. Environmental Protection Agency (U.S. EPA) to publish two columns a year in the *Journal*. ORD is the scientific research arm of U.S. EPA. ORD conducts the research for U.S. EPA that provides the foundation for credible decision making to safeguard human health and ecosystems from environmental pollutants.

In these columns, authors from ORD will share insights and information about the research being conducted on pressing environmental health issues. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of U.S. EPA.

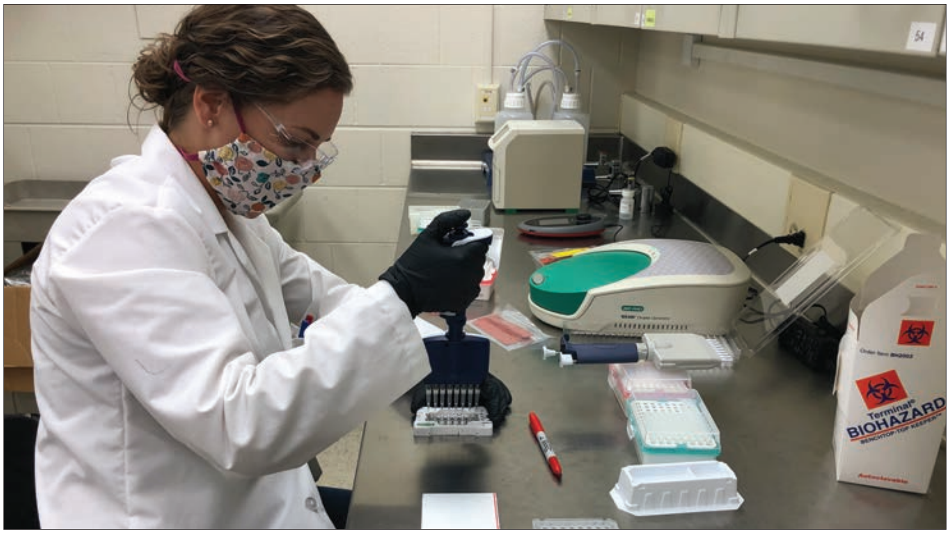
Dr. Gregory Sayles is the director of the Center for Environmental Solutions and Emergency Response within ORD.

Each year, communities across the U.S. experience emergencies such as oil spills, accidental and intentional releases of hazardous substances, natural disasters including floods and wildland fires, and homeland security incidents. Almost any emergency has an environmental component to be considered, each with unanticipated challenges that impact the health of communities. With other federal partners, the U.S. Environmental Protection Agency (U.S. EPA) plays a critical but often behind-the-scenes role in implementing the federal response to emergencies at all scales, providing on the ground emergency assistance and technical support to state and community first responders. This role operationalizes several of the 10 Essential Public Health Services (Centers for Disease Control and Prevention, 2021).

The role of U.S. EPA in emergency response initially focused on oil spills and hazardous substances releases, and U.S. EPA continues to lead federal coordination on these actions under the National Response Framework (Federal Emergency Management Agency, 2016). This role expanded to address additional threats like chemical, radiological, and biological attacks, particularly after the September 11, 2001, terrorist attacks and anthrax contamination of the U.S. Capitol. Today, U.S. EPA's emergency responsibilities include protecting the nation's drinking water supply and responding to the cleanup of both localized and wide-area incidents and natural disasters.

The Office of Research and Development (ORD) within U.S. EPA provides the scientific foundation necessary to support U.S. EPA in its emergency response activities to tackle a variety of environmental health challenges and increase U.S. capabilities to prepare for and respond to emergencies. ORD researchers work closely with federal, state, tribal, and local partners during emergency responses, conduct research to support long-term recovery efforts after disasters, and identify ways to increase preparedness and resilience in the future. In the last decade, ORD researchers have contributed to real-time solutions needed to address the environmental aftermaths of the Deepwater Horizon oil contamination in the Gulf of Mexico; the Gold King Mine release of heavy metals that contaminated the Animas and San Juan Rivers; Hurricanes Harvey, Irma, and Maria in 2017; ricin toxin and fentanyl cleanups across the country; decontamination efforts following anthrax attacks; and environmental impacts of the avian influenza outbreak in poultry across the U.S. Midwest in 2015.

Often the disasters for which ORD researchers provide support are unique, unanticipated circumstances where emergency responders have limited familiarity and practice, and there is little existing scientific information available. In these novel situations, ORD provides rapid scientific input to emergency responders by triaging requests for emergency assistance, identifying the right team of scientific experts, coordinating closely with frontline responders to the emergency (e.g., federal on-scene



Measuring SARS-CoV-2 mRNA in a wastewater sample at the U.S. Environmental Protection Agency (U.S. EPA) Office of Research and Development laboratory in Cincinnati, Ohio. Photo courtesy of U.S. EPA.

coordinators, public health departments, water utilities), and applying current scientific research or conducting new studies to inform response. Recent examples include assistance in addressing the Ebola crisis in the U.S. in 2014 and the SARS-CoV-2 virus pandemic that began in 2020.

Although the U.S. was spared a large Ebola outbreak in 2014, the horrifying outbreak in West Africa and the arrival of the first confirmed Ebola case in the U.S. highlighted the nation's lack of Ebola-specific environmental response protocols, particularly regarding the management of vast amounts of Ebola-contaminated medical waste and facility decontamination procedures. Working with the Ebola virus requires a level 4 biological safety laboratory, a capability that is uncommon and costly; thus, environmental response studies had not been conducted with the Ebola virus.

ORD researchers were called upon by U.S. EPA emergency responders and state and local agencies to provide advice on: how best to clean up ambulances, aircraft, and residences of infected patients; decontamination of personal protective equipment; management of Ebola-contaminated waste; and the fate of the virus in wastewater treatment. Although lacking in Ebola-specific data, researchers did have deep expertise in conducting studies on these topics using other viruses and bacteria. ORD researchers utilized this experience and extrapolated scientific results from these related studies to provide scientifically sound and timely advice during the outbreak. For example, researchers advised U.S. EPA's Office of Emergency Management in the development, training, and deployment of guidance for U.S. EPA responders on how best to support an Ebola-related situation. ORD also contributed to the development of national guidance on how to manage Ebola-laden and similar wastes by adapting and communicating prior research results from a U.S. National Security Council work group of federal, state, and private sector stakeholders (U.S. Department of Transportation, 2019).

The environmental response to the current COVID-19 pandemic caused by the SARS-CoV-2 virus has likewise required ORD researchers to extrapolate research results, as well as to conduct new focused, real-time studies. Early in the pandemic, U.S. EPA responders, state and local agencies, and the private sector sought advice from ORD researchers in addressing the environmental challenges of this novel virus. Several of these questions included:

- Do disinfectants and other antimicrobial products work well when applied to real-world surfaces common in public spaces, such as handrails, carpets, upholstery?
- Can personal protective equipment be disinfected and reused by healthcare workers?
- Can virus laden aerosols in public spaces, such as schools and mass transit vehicles, be treated effectively by commercially available devices?
- Can municipal sewage be monitored for the virus to reflect the community's rate of infection?
- Are masks protective if they are out of date or reused?

While providing technical advice as needed, ORD researchers also quickly started short-term, applied research studies to address these (and other) questions (U.S. Environmental Protection Agency, 2021). These studies have engaged community partners as part of the research process to best tailor support. Research teams include ORD principal investigators and the end users including transit agencies, U.S. EPA policy makers and responders, government agencies including the Centers for Disease Control and Prevention, state health and environment agencies, the private sector, and others. For example, ORD researchers are working closely with the New York City Transit Authority and the Los Angeles County Metropolitan Transportation Authority to assess options to reduce potential exposure of riders to the virus on their trains and buses. The local agencies have helped prioritize the disinfection studies that ORD researchers have conducted, and they have used the results of the testing to inform their decisions that affect millions of riders.

In another example, ORD researchers quickly developed applied methods to measure SARS-CoV-2 mRNA markers in wastewater (see photo above) and to support the development of Ohio's statewide sewage monitoring effort (Ohio Department of Health, 2021), thereby giving state public health officials another measure of severity of infection at the local level. ORD researchers continue to share this newly gained expertise with other states and institutions that are establishing their own sewage monitoring programs.

In the years ahead, the U.S. will be challenged by environmental emergencies that cannot be anticipated and have not been faced before; however, U.S. EPA and its researchers will continue to respond and provide emergency support. U.S. EPA's successful response to these disasters depends on ORD's foundational scientific depth, the nimble ability of its researchers to rapidly apply existing science and conduct new studies, and its continued engagement with emergency responders, decision makers, and the environmental and public health communities, including the local environmental health practitioner community. These relationships will continue to be critical to protect public health during emergencies by getting the right scientific expertise to the people who need it.

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- Twitter: https://twitter.com/nehaorg
- LinkedIn: www.linkedin.com/company/national-environmental-health-association

EH CALENDAR

UPCOMING NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION (NEHA) CONFERENCE

April 20–21, June 1–2, and July 14–15, 2021: NEHA 2021 Annual Educational Conference & Exhibition Three-Part Virtual Series, www.neha.org/aec

NEHA AFFILIATE AND REGIONAL LISTINGS

California
April 8–May 6, 2021: 2021 California Conference of Directors of Environmental Health (CCDEH) Training Series (Virtual), CCDEH and the California Environmental Health Association, www.ccdeh.org

Colorado
September 14–17, 2021: 65th Annual Education Conference, Colorado Environmental Health Association, http://www.cehaweb.com

Missouri
August 10–13, 2021: Annual Education Conference, Missouri Environmental Health Association, Springfield, MO, https://mehamo.org

National Capital Area
May 3, 2021: Spring Virtual Educational Conference, National Capital Area Environmental Health Association, https://www.ncaeha.org/events

Nevada
May 4–5, 2021: NvEHA/NFSTF Joint Virtual Conference: Evolutions in Environmental Health, Nevada Environmental Health Association (NvEHA) and the Nevada Food Safety Task Force (NFSTF), www.nveha.org

Texas
October 6–8, 2021: 65th Annual Educational Conference, Texas Environmental Health Association, Round Rock, TX, https://www.myteha.org

Utah
CANCELED: May 5–7, 2021: Spring Conference, Utah Environmental Health Association, Kanab, UT, www.ueha.org/events.html

Virginia
May 12, 2021: 2021 Spring Onsite Education Day (Virtual), Virginia Environmental Health Association, http://virginiaeha.org

Washington
May 2021: 2021 Annual Educational Conference (Virtual), Washington State Environmental Health Association, www.wseha.org/2021-aec

TOPICAL LISTINGS

Water Quality
August 24–26, 2021: *Legionella* Conference: Prevention of Disease and Injury From Waterborne Pathogens in Health Care (Virtual), NSF Health Sciences and NEHA, www.legionellaconference.org

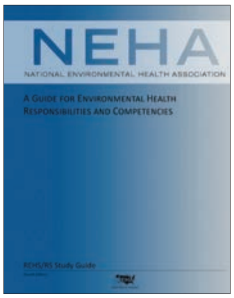
RESOURCE CORNER

Resource Corner highlights different resources the National Environmental Health Association (NEHA) has available to meet your education and training needs. These resources provide you with information and knowledge to advance your professional development. Visit NEHA's online Bookstore for additional information about these and many other pertinent resources!

NEHA BOOKSTORE
www.neha.org/store

REHS/RS Study Guide (4th Edition)

National Environmental Health Association (2014)



The Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential is the National Environmental Health Association's (NEHA) premier credential. This study guide provides a tool for individuals to prepare for the REHS/RS exam and has been revised and updated to reflect changes and advancements in technologies and theories in the environmental health and protection field. The study guide covers the following topic areas: general environmental health; statutes and regulations; food protection; potable water; wastewater; solid and hazardous waste; zoonoses, vectors, pests, and poisonous plants; radiation protection; occupational safety and health; air quality; environmental noise; housing sanitation; institutions and licensed establishments; swimming pools and recreational facilities; and disaster sanitation.

308 pages / Paperback
Member: $149 / Nonmember: $179

Control of Communicable Diseases Manual (20th Edition)

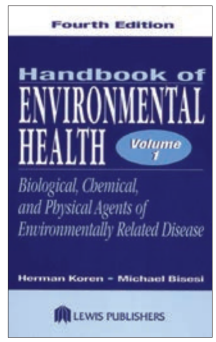
Edited by David L. Heymann, MD (2015)

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 an 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 Registered Environmental Health Specialist/Registered Sanitarian and Certified Professional–Food Safety credential exams.

729 pages / Paperback
Member: $59 / Nonmember: $68

Handbook of Environmental Health, Volume 1: Biological, Chemical, and Physical Agents of Environmentally Related Disease (4th Edition)

Herman Koren and Michael Bisesi (2003)

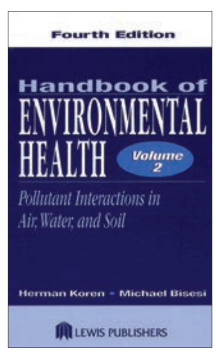


A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the internal environment. It was written by experts in the field and copublished with NEHA. A variety of environmental issues are covered such as food safety, 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
Member: $215 / Nonmember: $245

Handbook of Environmental Health, Volume 2: Pollutant Interactions With Air, Water, and Soil (4th Edition)

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 NEHA. 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.

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NEHA NEWS

NEHA Partners With NNPHI for Project Firstline

The National Environmental Health Association (NEHA) is proud to partner with the National Network of Public Health Institutes (NNPHI) for Project Firstline (www.cdc.gov/infectioncontrol/projectfirstline/index.html). Project Firstline is a collaborative of diverse healthcare, public health, and environmental health partners who have come together to provide foundational knowledge of infection control.

To stop the spread of infectious disease threats, including COVID-19, professionals in healthcare, public health, and environmental health need a knowledge of infection control and should understand and be ready to implement infection control protocols and procedures in their work duties and functions. This collaboration will provide these professionals with valuable infection control training to aid them in protecting their communities and the nation from infectious disease threats.

On March 30, 2021, NEHA and NNPHI cohosted a Project Firstline Environmental Health Q&A Session aimed at providing environmental health professionals with infection control training. Presenters of the session included Gina Bare, associate director of NEHA's Program and Partnership Development, and Dr. Timothy Landers, infection prevention control specialist and associate professor within the College of Nursing at Ohio State University.

Learn more about NEHA's involvement in Project Firstline at www.neha.org/eh-topics/preparedness-0.

NEHA and NCHH Release New Guide for Safer Cleaning and Disinfection

NEHA and the National Center for Healthy Housing (NCHH) have compiled a *Healthy Homes Guide to Cleaning and Disinfection* in response to the COVID-19 pandemic. As part of a larger strategy that includes practicing social distancing and wearing a mask, cleaning and disinfection can help keep yourself, friends, family, and communities safe and healthy. Cleaning and disinfecting are also important for protecting against the seasonal flu and other infectious diseases.

Developed for the general public, including homeowners and residents, this resource is a compilation of expert guidance, key messages, and a summary of information with links to external resources. Topics addressed in this guide include homes, hand hygiene and personal protective equipment, products, ventilation, and more.

Due to federal recommendations and other state and local directives, you are likely cleaning and disinfecting as part of a larger personal or professional strategy to prevent COVID-19 transmission and infection. This guide will help you make decisions and navigate the processes of cleaning and disinfection safely and effectively. Learn more at https://bit.ly/NCHHinfoSafeClean about the expert guidance on cleaning and disinfection to protect yourself, your home, and your community to help prevent the spread of COVID-19 and other infectious diseases.

IN MEMORIAM

Dennis Catanyag

On January 14, 2021, Dennis Catanyag was fatally wounded while performing duties protecting and serving his community as a registered environmental health specialist (REHS) for Sacramento County in California. "He had a passion for public service and the health and safety of people in the community. He was very well liked by his colleagues, who enjoyed his lively personality and respected his professional integrity," stated Ann Edwards, Sacramento County acting executive, in a letter to county employees. "The death of Dennis is an extraordinary loss to his family, the county, and the community. Our hearts go out to his friends and family as they cope with this incomprehensible tragedy."

Catanyag earned his bachelor of science degree in biological sciences with a minor in chemistry in 1998 from California State University, Sacramento. He became an REHS in August 2002. He worked for Sacramento County for 15 years in the Environmental Health Division conducting food protection, recreational health, and Childhood Lead Poisoning Prevention Program (CLPPP) inspections. Catanyag most recently worked as the program lead for CLPPP where he was able to practice his commitment to protecting children from lead exposure in their homes. His professional integrity, empathy, and friendly demeanor made him well respected.

Prior to working in Sacramento County, Catanyag worked in San Joaquin County as a senior REHS for 4 years conducting Certified Unified Program Agency (CUPA) inspections. He was a dedicated employee who was committed to his family and his job. He had a passion for protecting public health, especially children.

"I think about his balance and intensity, both of which I try to emulate. One may see these as opposing but that was the irony that made Dennis unique. He was intense in a sense that he was fiercely competitive. Tennis, poker, marathons, escape rooms—he always tried to win. Super focused and relentless. He put his best

DirecTalk
continued from page 46

Congresswoman Brenda Lawrence (D-Michigan) may reintroduce the Environmental Health Workforce Act. The act could receive serious consideration in this Congress given its constituency and progressive orientation. Our fingers are crossed.

While these glimmers of renewed interest in our profession are reassuring, now is not the time to breathe a sigh of relief. The National Association of County and City Health Officials Chief Executive Officer Lori Freeman and President Jennifer Kertanis spoke to our board in February. Approximately 20% of the local health officials nationwide have resigned, retired, or been forced out of office as a function of the pandemic. The White House has released preliminary climate plans that regrettably failed to include the U.S. Department of Health and Human Services and Centers for Disease Control and Prevention. I am apoplectic. The prior U.S. Environmental Protection Agency administrator runs point on domestic climate issues, she knows better, and we can do better.

Amid these developments, I have commissioned the creation of a short, 2.5-minute animated video. This video will be targeted at elected officials, boards of health, and influencers. It will not be technical. It will not be scientific. It will not be complicated. The through line is that our profession is the guardian angel that protects our nation's health, safety, and economic security. The colors, narration, and sequencing have been meticulously considered. While the success and impact of the video are uncertain, I feel that if we are ever going to change the narrative around our profession, we need to take measured risks and experiment with unproven ideas like this one. Your careers and the health of the nation deserve no less.


Mono Lake at dawn. Photo courtesy of David Dyjack.

Mono Lake at dawn is breathtaking. The lake, which is 2–3 times saltier than ocean water, is also a vibrant ecosystem comprised of algae, brine shrimp, and alkali flies. These comprise the base of a food chain that nourishes millions of migrating shorebirds. In many parts of the country, the public health enterprise has had its resources redirected to other parts of government, leaving environmental health as the elegant and inspiring tufas in an ecosystem otherwise drained of leadership and pummeled by some elements of society I, for one, thank you and am inspired by your courage, tenacity, and commitment to your communities. At the dawn of a new era, you stand out as an inspiration.

Dave

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IN MEMORIAM CONTINUED

foot forward on everything he did and I had a deep admiration for that. With respect to balance, I envied how he was able to juggle everything he had in his life and how well he did it. He lived life to the fullest and no one facet was lacking," stated long-time friend John Lai in his eulogy for Catanyag.

Donations can be made to the GoFundMe account set up to provide support for Catanyag's family at www.gofundme.com/f/dennis-catanyag. An online memorial site dedicated to him can be viewed at www.forevermissed.com/dennis-catanyag.

NEHA extends its deepest sympathies to the family, friends, and colleagues of Dennis Catanyag. His passion and devotion to protecting the health and safety of the communities he served, as well as the love and joy he brought to those around him, will not be forgotten.

Source: California Environmental Health Association, Oregon Environmental Health Association, Sacramento County Environmental Health Division, and www.forevermissed.com/dennis-catanyag.

Editor's Note: If you would like to share information about the passing of an environmental health professional to be mentioned in a future In Memoriam, please contact Kristen Ruby-Cisneros at kruby@neha.org. The *Journal* will publish the In Memoriam section twice a year in the June and December issues, or in other issues as determined appropriate.

DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

Lee Vining

I am convinced my fingerprints remain etched into the steering wheel of the Silver Dragon, the nickname of our Nissan Xterra. Vehicle traffic on U.S. Route 395 had been limited to those equipped with chains. Police were out in enforcement. Oddly, law enforcement attention was on the northbound traffic narrowly targeting road warriors making their way from Bishop, California, in the south to Lee Vining, California, in the north. I was in Lee Vining, planning to head south during an epic snowstorm on Thanksgiving weekend. Since I was riding solo, and jacked up on espresso, I made the poor decision to saddle up the two-wheel drive Silver Dragon, sans chains, and risk the steep slopes and motor on down to Bishop. That drive was one for the ages. A 1-hour trip under normal conditions turned into an iconic 3-hour adventure worthy of a Hunter S. Thompson *Fear and Loathing in Las Vegas* yarn.

Lee Vining lies in Eastern Sierra, which is magical in many respects, particularly for those with an interest in water policy, environmental health, and the ecological impacts of humans on the environment. I was there with camera in hand to visit the old ghost town of Bodie and photograph the famous tufas—calcium carbonate formations that revealed themselves in Mono Lake after a thirsty Los Angeles diverted the lake's main water source in 1941. In short, the Los Angeles Department of Water and Power began diverting Mono Lake's tributary streams 350 miles to the south. The water volume dropped precipitously, leaving some serious eye candy in the form of tufas, as well as an awful ecological legacy. For those of you into movies, *Chinatown*, the 1974 neo-noir mystery film directed by Roman Polanski, captures some of the drama of water resource decisions of that period.

> *You stand out as an inspiration.*

The adrenaline rush of dropping below the snow line pulsed through my veins as I careened through Bishop in route to Loma Linda, where I was employed as the dean of the School of Public Health. That memory returned to me yesterday as I enjoyed a lengthy zoom conversation with one of my colleagues at the Centers for Disease Control and Prevention. The new Congress and administration imbued him with a sense of possibilities and enthusiasm customarily associated with a beautiful sunrise. Perhaps the recent draining of the public health enterprise to feed hungry bureaucrats pining for quick fixes and limited government can be amended after all.

With the dawn of the 117th Congress, there are some priorities that have direct relevance to us, accompanied by some alarming developments. First notes of optimism, and the elephant in the room: climate and health. There appears to be a serious all-government approach to climate issues, with an emphasis on climate justice. Communities that shoulder a disproportionate share of the burden are regretfully communities with the smallest voices and influence. That could change over the next 4 years. Perhaps not a moment too soon. As reported in the latest scientific studies, the Atlantic meridional overturning circulation (AMOC), which drives the currents of the Atlantic Ocean, is showing evidence of stress. Recent reports suggest that AMOC is getting weaker, which has implications for the entire marine food chain, as well as the relatively mild environment enjoyed by residents of western Europe. This thermohaline circulation plays many other critical roles in our lives, particularly for those of us who reside on the eastern seaboard. We must take climate and health seriously. I am flummoxed by our country's propensity for cures over prevention in most matters of strategic national importance.

The federal government has identified other priorities. We can anticipate renewed interest and investment in reducing lead exposure, addressing root causes of harmful algal blooms, and maturing our efforts around per- and polyfluoroalkyl substances (PFAS), the group of man-made chemicals that have been showing up in drinking water in many of our communities.

We plan to strike while the iron is hot and in that spirit, have planned a virtual NEHA Hill Day 2021 on April 22. The NEHA Board of Directors will engage in about 50 individual meetings with federal lawmakers to ensure your interests are being advanced in the halls of Congress and felt throughout the federal government. I am delighted to report that

continued on page 45