# Community Needs Assessment After Microcystin Toxin Contamination of a Municipal Water Supply — Lucas County, Ohio, September 2014

Carolyn L. McCarty, PhD[1,2]; Leigh Nelson, MPH[2,3]; Samantha Eitniear, MPH, VPH[4]; Eric Zgodzinski, MPH[4]; Amanda Zabala, MPH[1,3];
Laurie Billing, MPH[1]; Mary DiOrio, MD[2]

On August 1, 2014, routine testing at the Collins Park Water Treatment Plant in Lucas County, Ohio, revealed microcystin toxin levels in drinking water had reached 3.19 $\mu$g/L, surpassing the Ohio Environmental Protection Agency (EPA) drinking water advisory threshold of 1.0 $\mu$g/L. Microcystin is a hepatoxin released by cyanobacteria in certain harmful algal blooms. Exposure to microcystin has been associated with gastrointestinal and hepatic illness in both humans and animals (*1–3*). On August 2, a do-not-drink advisory was issued, warning community members not to drink, boil, or use the water for cooking or brushing teeth. Public health officials used traditional and social media outlets to disseminate public health messages to affected communities. On August 4, 2014, the advisory was lifted after multiple water samples confirmed microcystin toxin levels had dropped below the advisory threshold. To assess communication strategies, water exposure, and household needs, the Ohio Department of Health (ODH) and Toledo-Lucas County Health Department (TLCHD) conducted a Community Assessment for Public Health Emergency Response (CASPER) in Lucas County. Most households (88.1%) reported hearing about the advisory the morning it was issued, but 11% reported drinking and 21% reported brushing teeth with municipal water during the advisory. Household members reported physical (16%) and mental (10%) health concerns that they believed were related to the advisory and activity disruptions including temporarily staying outside of the home (6%) during the advisory and continued use of alternative water sources after the advisory was lifted (82%). During a do-not-drink advisory, governmental agencies and community partners need to engage in joint prevention and response efforts to decrease water exposure and prevent activity disruptions.

CASPER is a household-level survey methodology used to conduct a rapid community needs assessment after a public health emergency (*4*). Although the do-not-drink advisory was issued for all customers of the Collins Park Water Treatment Plant (440,552 residents in 108,301 households across four counties in 2010), the survey focused on Lucas County, where 84% of affected customers resided (*5*). A two-stage cluster sampling method (*4*) was used, with the goal of completing 210 household interviews. During the first stage, 30 Lucas County census tracts (clusters) were selected with probability of selection proportional to the number of housing units (size) (*4*).

**Continuing Education** examination available at http://www.cdc.gov/mmwr/cme/conted_info.html#weekly.

Interview teams then randomly selected seven housing units within each cluster and interviewed one adult per household.

A multiagency working group with representation from ODH, TLCHD, and CDC developed a questionnaire using questions modified from a previous CASPER (6). Regarding health issues, participants were asked to respond to the following initial question, "Since the do-not-drink advisory on August 2, 2014, did anyone in your household have any health issues they felt were related to the do-not-drink advisory?" CDC experts trained interview teams composed of TLCHD personnel, ODH personnel, and community volunteers to administer the survey. Interview teams conducted door-to-door surveys during September 11–15, 2014, approximately 6 weeks after the advisory was issued. Each questionnaire took approximately 15 minutes to administer. Frequencies were calculated using CDC Epi Info version 7.1.3. Weighted frequencies, based on probability of selection, are reported (4).

Among 314 households contacted, 171 (54.5%) completed the survey. Approximately 23% of these households included ≥1 member aged ≥65 years and 8.1% included ≥1 member aged ≤2 years (Table 1). Approximately 96% of households had heard about the advisory the same day it was issued, including 88.1% who learned of it in the morning. The most common information sources regarding the advisory were television (82.3%), word of mouth (54.5%), and social media (41.8%), with television reported as the most reliable source of information (73.4%).

**TABLE 1. Number and percentage of households reporting selected characteristics — Lucas County, Ohio, 2014 (N = 171)\***

| Characteristic | No. | Estimated no. of households[†] | % of sampled households (95% CI) |
|---|---|---|---|
| **Structure** | | | |
| Single family | 145 | 88,274 | 85.7 (74.4–96.9) |
| Mobile home | 6 | 5,415 | 5.3 (-2.6–13.2) |
| Multiple unit | 9 | 5,759 | 5.6 (-0.9–12.1) |
| Other | 7 | 3,610 | 3.5 (-2.7–9.7) |
| **No. of persons in household** | | | |
| ≤2 | 75 | 46,724 | 43.4 (33.9–52.8) |
| 3–4 | 63 | 38,412 | 35.6 (27.1–44.1) |
| ≥5 | 32 | 22,649 | 21.0 (11.9–30.2) |
| **Home ownership** | | | |
| Own | 113 | 75,501 | 70.4 (59.4–81.3) |
| Rent | 56 | 31,768 | 29.6 (18.7–40.6) |
| **Age group (yrs) of persons in household[§]** | | | |
| ≤2 | 16 | 8,630 | 8.1 (4.3–11.9) |
| 2–17 | 78 | 51,692 | 48.5 (39.2–57.8) |
| 18–64 | 147 | 93,362 | 87.6 (81.7–93.6) |
| ≥65 | 34 | 24,462 | 23.0 (13.9–32.0) |
| **Race/Ethnicity of persons in household[§]** | | | |
| Hispanic or Latino | 18 | 12,652 | 11.7 (5.1–18.4) |
| White | 119 | 74,152 | 68.5 (55.3–81.7) |
| Black | 50 | 32,422 | 29.9 (17.2–42.7) |
| Other race | 16 | 10,426 | 9.6 (4.4–14.9) |
| **Highest education level in household** | | | |
| High school, GED, or less | 43 | 31,957 | 29.9 (19.3–40.6) |
| Some college | 35 | 21,205 | 19.9 (13.6–26.1) |
| Two- or four-year degree | 59 | 36,367 | 34.1 (26.6–41.6) |
| Graduate or professional degree | 31 | 17,225 | 16.1 (8.4–23.9) |

**Abbreviations:** CI = confidence interval; GED = general equivalency diploma.
\* N values might differ because of item nonresponse.
[†] Based on 2010 U.S. Census estimates for Lucas County, Ohio.
[§] Households could provide multiple responses.

During the advisory, 67.5% of households used purchased water; however, 61.0% indicated continued use of municipal water in some capacity, primarily for bathing (43.7%), washing hands (32.0%), and brushing teeth (19.6%) (Table 2). Some households (10.7%) reported that members drank municipal water and 10.2% consumed food prepared with the water.

In 16.2% of households, at least one person reported physical health symptoms attributed to the advisory; gastrointestinal symptoms were most commonly reported (diarrhea 12.1%, nausea 9.1%, and vomiting 6.2%) (Table 3). Most (89.1%) households reporting symptoms indicated that the health issues were not serious enough to seek medical care. Approximately 10% of households reported mental health symptoms attributed to the advisory, most commonly anxiety or stress (7.0%). Among pet-owning households, 3.8% reported pet illness that the household member attributed to water exposure. Additional household activity disruptions included child care center or school closure (2.3%), work cancellation (5.7%), staying outside the home overnight to access alternative water sources (5.8%), and interruptions to routine medical services (7.9%).

After the advisory was lifted, 81.9% of households used an alternative water source during at least the first day, primarily for drinking (77.8%) or preparing food (47.2%). Approximately 6 weeks after the advisory was lifted, 58.5% of households reported using an alternative water source.

## Discussion

The majority of households in the affected communities learned about the advisory quickly through traditional and social media outlets. However, many were still exposed to the water or otherwise affected by the emergency. Some households reported physical health symptoms that they attributed to the advisory, including gastrointestinal illness, skin irritation, eye and head pain, and respiratory illness. These physical symptoms are consistent with those reported in previous studies of recreational exposure to microcystin and harmful algal bloom-associated disease outbreaks ([1],[2]). Some households reported mental health symptoms attributed to the advisory, primarily anxiety and stress and disruptions of daily activities. Many households relied on alternative water sources, often purchased water, during and after the advisory. These findings indicate the need for effective public health preparedness and response to meet various water and health needs of residents in the event of a do-not-drink advisory related to microcystin contamination.

**TABLE 2. Number and percentage of households reporting water use and sources during and after the advisory — Lucas County, Ohio, 2014 (N = 171)\*,†**

| Characteristic | No. | Estimated no. of households§ | % of sampled households (95% CI) |
|---|---|---|---|
| **Municipal water use during the advisory ¶** | | | |
| Any use | 107 | 66,089 | 61.0 (52.6–69.4) |
| Drank | 18 | 11,552 | 10.7 (5.2–16.1) |
| Washed hands | 57 | 34,669 | 32.0 (24.9–39.2) |
| Brushed teeth | 36 | 21,179 | 19.6 (12.9–26.2) |
| Bathed | 76 | 47,317 | 43.7 (36.5–50.9) |
| Ate or drank food prepared with water | 17 | 11,036 | 10.2 (4.4–16.0) |
| Washed clothes | 34 | 18,420 | 17.0 (11.1–22.9) |
| Washed dishes | 28 | 15,721 | 14.5 (8.7–20.3) |
| Other | 18 | 10,744 | 9.9 (5.4–14.4) |
| **Alternative water sources used during the advisory** | | | |
| Purchased water | 120 | 73,138 | 67.5 (59.8–75.3) |
| Water from a friend or relative | 37 | 22,227 | 20.5 (13.5–27.6) |
| Water from a water distribution site | 37 | 25,683 | 23.7 (14.7–32.7) |
| Other | 13 | 8,217 | 7.6 (2.7–12.5) |
| **Alternative water use after the advisory was lifted** | | | |
| Any use | 136 | 88,050 | 81.9 (75.1–88.6) |
| Drank | 129 | 84,440 | 78.0 (69.7–86.2) |
| Washed hands | 25 | 17,638 | 16.3 (7.6–25.0) |
| Brushed teeth | 57 | 34,562 | 31.9 (22.1–41.7) |
| Bathed | 11 | 6,137 | 5.7 (2.1–9.2) |
| Ate or drank food prepared with water | 79 | 51,125 | 47.2 (37.6–56.8) |
| Made baby formula | 11 | 5,965 | 5.5 (2.1–8.9) |
| Washed clothes | 8 | 4,418 | 4.1 (1.5–6.7) |
| Washed dishes | 12 | 9,661 | 8.9 (1.8–16.1) |
| Other | 49 | 33,324 | 30.8 (20.5–41.0) |

**Abbreviation:** CI = confidence interval.
* N values might differ because of item nonresponse.
† Households could provide multiple responses.
§ Based on 2010 U.S. Census estimates for Lucas County, Ohio.
¶ No households reported using municipal water to make baby formula during the advisory.

**TABLE 3. Number and percentage of households reporting household impacts — Lucas County, Ohio, 2014 (N = 171)*,†**

| Characteristic | No. | Estimated no. of households§ | % of sampled households (95% CI) |
|---|---|---|---|
| **Household physical health symptoms** | | | |
| Any illness | 25 | 17,431 | 16.2 (7.6–24.8) |
| Nausea | 16 | 9,833 | 9.1 (4.2–14.0) |
| Vomiting | 10 | 6,739 | 6.2 (1.9–10.5) |
| Abdominal pain | 11 | 8,028 | 7.4 (2.5–12.4) |
| Diarrhea | 19 | 13,134 | 12.1 (5.9–18.4) |
| Skin irritation or itching | 6 | 5,879 | 5.4 (-1.6–12.4) |
| Headache | 6 | 3,988 | 3.7 (0.3–7.0) |
| Eye irritation or pain | 2 | 2,321 | 2.1 (-1.4–5.7) |
| Respiratory illness or cough | 2 | 2,321 | 2.1 (-1.4–5.7) |
| Other | 3 | 1,547 | 1.4 (-0.7–3.6) |
| **Household mental health symptoms** | | | |
| Any mental health concerns | 14 | 10,443 | 9.9 (4.4–15.4) |
| Agitated behavior | 3 | 2,235 | 2.1 (-0.5–4.7) |
| Anxiety or stress | 10 | 7,607 | 7.0 (2.3–11.8) |
| Difficulty concentrating | 3 | 2,235 | 2.1 (-0.5–4.7) |
| Loss of appetite | 5 | 5,243 | 4.8 (0.2–9.5) |
| Trouble sleeping or nightmares | 5 | 4,556 | 4.2 (0.0–8.4) |
| Alcohol or drug use | 1 | 516 | 0.5 (-0.5–1.5) |
| Other | 4 | 2,149 | 2.0 (0.1–3.9) |
| Pet illness¶ (n = 120) | 6 | 3,988 | 3.8 (0.7–7.0) |
| **Activity disruptions** | | | |
| Interruptions of routine health services | 15 | 8,509 | 7.9 (1.1–14.6) |
| Difficulty taking medications | 4 | 2,355 | 2.2 (0.1–4.4) |
| Temporary displacement | 12 | 6,275 | 5.8 (1.7–9.9) |
| Child care or school closure | 4 | 2,355 | 2.3 (0.1–4.5) |
| Work cancellation | 10 | 6,137 | 5.7 (2.4–9.0) |

**Abbreviation:** CI = confidence interval.
* N values might differ because of item nonresponse.
† Households could provide multiple responses.
§ Based on 2010 U.S. Census estimates for Lucas County, Ohio.
¶ Among households reporting pet ownership.

Harmful algal blooms and the toxins they produce have become a recurring concern for Ohio's recreational and drinking water systems (7). This is likely related to increased nutrient runoff (e.g., phosphorus and nitrogen), warmer temperatures, and sunlight (8); however, it might also be at least partially explained by increased surveillance. Ohio's first do-not-drink advisory related to microcystin was issued in 2013 when levels in treated drinking water of Carroll Township exceeded the threshold of 1.0 μg/L (9); however, because of prompt connection to an alternative water source, community exposure to microcystin was unlikely. Therefore, the 2014 Lucas County incident was Ohio's first opportunity to investigate community needs and the public health response associated with elevated microcystin in publicly distributed municipal water.

Since the 2014 event, Ohio has continued to work on activities to help prevent future harmful algal bloom-related events and illnesses. Critical government and community partnerships, substantial resource investment, and guideline and legislation development have focused on addressing nutrient runoff, enhancing surveillance for toxin levels and harmful algal bloom-associated illness, and improving response efforts. In July 2015, after the release of the U.S. EPA's first guidelines* for safe levels of microcystin in drinking water, the Ohio EPA released modified microcystin thresholds for a do-not-drink advisory.† The new drinking water thresholds are 0.3 μg/L for special populations and children aged <6 years and 1.6 μg/L for adults and children aged ≥6 years; these thresholds are far below the levels reached during the 2014 event in Lucas County (which peaked at 3.19 μg/L), indicating a continued need for prevention efforts.

The findings in this report are subject to at least three limitations. First, sampling weights were created using information from the 2010 U.S. Census and did not account for potential population changes since 2010. Because of jurisdictional lines, the sampling frame was limited to the affected communities within Lucas County and did not include the other affected counties; these limitations might influence representativeness of the findings. Second, all responses were self-reported and questionnaires were administered approximately 6 weeks after the advisory, introducing the potential

* http://yosemite.epa.gov/opa/admpress.nsf/0/547DC50C15C82AAF85257E3 D004D7F67.
† http://epa.ohio.gov/Portals/28/documents/HABs/PWS_HAB_Response_ Strategy.pdf.

**Summary**

What is already known about this topic?

Cyanobacteria can cause harmful algal blooms when wind and water currents facilitate their development, or nutrient (e.g., phosphorus and nitrogen) runoff accumulates. Harmful algal blooms can produce toxic chemicals, including microcystin, which can potentially affect the health of humans and animals when contact with contaminated water occurs.

What is added by this report?

When microcystin contaminated a municipal water supply and a do-not-drink advisory was issued in Lucas County, Ohio, residents self-reported physical and mental health symptoms, primarily gastrointestinal symptoms, anxiety, and stress. Households also reported school and work closures, interrupted medical care, financial burdens, and use of alternative water sources after the advisory was lifted.

What are the implications for public health practice?

Governmental agencies and community partners need to engage in joint prevention and response efforts. When a community is exposed to microcystin and a do-not-drink advisory is issued, public health partnerships need to mobilize to provide timely communication, alternative water sources, and physical and mental health resources.

for recall bias. Finally, because of the wording of the survey question (asking whether household members experienced symptoms that they attributed to the advisory) and the absence of baseline data or a comparison group, the ability to draw conclusions about the association between microcystin exposure and health effects is limited, and no cause and effect conclusions can be drawn.

The findings of this assessment highlight the importance of using both traditional and nontraditional media outlets for public health communications during a do-not-drink advisory, and for continued consumer education to reduce exposure to municipal water during the advisory and promote use of the municipal water once the advisory is lifted. Therefore, focusing educational efforts on both improving consumer understanding of the advisory and improving understanding of the safety of the public water system once the advisory is lifted is warranted. Additionally, collaboration among government agencies, community organizations, local businesses, and health care is important to meet community water and health

needs and minimize household burden related to a do-not-drink advisory. Finally, continued planning and investment in harmful algal bloom prevention and response efforts are critical for protecting the public's health.

[1]Epidemic Intelligence Service, Division of Scientific Education and Professional Development, CDC; [2]Ohio Department of Health; [3]CDC/CSTE Applied Epidemiology Fellowship; [4]Toledo-Lucas County Health Department, Ohio.

Corresponding author: Leigh Nelson, lanelson@columbus.gov, 614-645-6583.

## References

1. World Health Organization. Toxic cyanobacteria in water: a guide to their public health consequences, monitoring and management. Chorus I, Bartram J, eds. London, United Kingdom: E&FN Spon; 1999. http://www.who.int/water_sanitation_health/resourcesquality/toxcyanbegin.pdf
2. Hilborn ED, Roberts VA, Backer L, et al. Algal bloom-associated disease outbreaks among users of freshwater lakes—United States, 2009–2010. MMWR Morb Mortal Wkly Rep 2014;63:11–5. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6301a3.htm
3. Azevedo SM, Carmichael WW, Jochimsen EM, et al. Human intoxication by microcystins during renal dialysis treatment in Caruaru-Brazil. Toxicology 2002;181-182:441–6. http://dx.doi.org/10.1016/S0300-483X(02)00491-2
4. CDC. Community assessment for public health emergency response (CASPER) toolkit: second edition. Atlanta, GA: US Department of Health and Human Services, CDC; 2012. http://emergency.cdc.gov/disasters/surveillance/pdf/CASPER_Toolkit_Version_2_0_508_Compliant.pdf
5. US Census Bureau. QuickFacts (Lucas County, Ohio). Washington, DC: US Department of Commerce, US Census Bureau; 2010. http://www.census.gov/quickfacts/table/PST045215/39095,00
6. CDC. Disaster response and recovery needs of communities affected by the Elk River chemical spill, West Virginia. Atlanta, GA: US Department of Health and Human Services, CDC; 2014. http://www.dhhr.wv.gov/News/2014/Documents/WVCASPERReport.pdf
7. Wynne TT, Stumpf RP. Spatial and temporal patterns in the seasonal distribution of toxic cyanobacteria in Western Lake Erie from 2002–2014. Toxins (Basel) 2015;7:1649–63. http://dx.doi.org/10.3390/toxins7051649
8. Ohio Department of Health. Harmful algal blooms: implications for tap/drinking and recreational waters. Columbus, OH: Ohio Department of Health; 2016. https://www.odh.ohio.gov/odhprograms/eh/HABs/algalblooms.aspx
9. Ohio Environmental Protection Agency. Public water system harmful algal bloom response strategy. Columbus, OH: Ohio Environmental Protection Agency; 2014. http://epa.ohio.gov/Portals/28/documents/HABs/PWS_HAB_Response_Strategy_2014.pdf