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Campylobacteriosis Outbreak Associated with Contaminated Municipal Water Supply — Nebraska, 2017

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In March 2017, the Nebraska Department of Health and Human Services (NDHHS) and the Southwest Nebraska Public Health Department were notified of an apparent cluster of *Campylobacter jejuni* infections in city A and initiated an investigation. Overall, 39 cases were investigated, including six confirmed and 33 probable. Untreated, unboiled city A tap water (i.e., well water) was the only exposure significantly associated with illness (odds ratio [OR] = 7.84; 95% confidence interval [CI] = 1.69–36.36). City A is served by four untreated wells and an interconnected distribution system. Onsite investigations identified that a center pivot irrigation system intended to pump livestock wastewater from a nearby concentrated animal feeding operation onto adjacent farmland had malfunctioned, allowing excessive runoff to collect in a road ditch near two wells that supplied water to the city. These wells were promptly removed from service, after which no subsequent cases occurred. This coordinated response rapidly identified an important risk to city A's municipal water supply and provided the evidence needed to decommission the affected wells, with plans to build a new well to safely serve this community.

Investigation and Results

On March 10, 2017, NDHHS was notified of five reports of campylobacteriosis in the Southwest Nebraska Public Health Department jurisdiction. Two positive culture reports and three positive culture-independent diagnostic tests, specifically a gastrointestinal polymerase chain reaction (PCR) panel, were received from persons not living together. Campylobacteriosis is a reportable condition in Nebraska, and this number of cases was higher than expected; during 2006–2016, an average of one *Campylobacter* case was reported in a city A resident every 3 years. Initial questioning of ill persons did not include an assessment of exposure to untreated drinking water and suggested ground beef consumption as a possible shared exposure. The Nebraska Department of Agriculture Food Safety and Consumer Protection obtained distribution records for poultry and ground beef for two local restaurants and one local grocery store. The distribution of poultry and ground beef was evaluated by reviewing the routing records of these products to their source, and no evidence of a shared poultry source was identified. The ground beef was not ground in-house at the grocery store, and the distributors that supplied ground beef to the grocery store and each of the two local restaurants were not shared. Through interviews of city A residents and

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business owners, investigators were made aware of a report of standing water that "smelled of cattle manure" in a roadside ditch near two municipal water wells.

A collaborative on-site investigation revealed that during the pumping of a large volume of livestock wastewater from a concentrated animal feeding operation through a center pivot irrigation system, the system malfunctioned at an undetermined time. The wastewater was intended to be placed on adjacent farmland. This malfunction allowed excessive runoff to flood a road ditch approximately 15 feet (4.6 m) from two municipal water well houses (3 and 4) that had been operating 6 days before the onset of illness in the first patient. The presence of this standing water was confirmed by city A water operators, who reported seeing water in the ditch for 4 days (February 22–25) (Figure). Pump records indicated that during February 22–27, well 3 was in use, and during February 28–March 7, well 4 was in use (Table 1). During both periods, another well (well 2) was also operating. Wells are rotated in and out of service by city operators as part of regular operations. Water is distributed through the well system without any disinfection or filtration. Routine total coliform and *Escherichia coli* testing of water from the distribution system was performed on March 8; however, only wells 2 and 5 were operating on that date. As part of the investigation, additional coliform and *E. coli* testing was performed again on March 16 on direct samples from wells 2, 3, 4, and 5; bacterial culture specifically for *Campylobacter* was performed on March 20 (wells 4 and 5) and 27 (wells 2 and 3). All samples were negative for coliforms and *Campylobacter.* No additional pump or testing records were reviewed.

On March 16, Nebraska Department of Environmental Quality and the Department of Agriculture conducted an additional investigation of two concentrated animal feeding operation–certified waste lagoons (a manufactured basin that collects livestock waste and water in an oxygen-deprived setting to promote anaerobic conditions as a way to manage refuse)* and associated use of three pivot irrigation systems. The investigation team observed that water from the waste lagoons had been pumped through a pivot onto an adjacent field, which is a common farming practice for fertilizing farm ground or watering crops. City operators confirmed that on February 24 they had observed flow of livestock wastewater into the road ditch near well 4. They followed the wastewater up the road ditch and reported that it came out of the farmland upstream from the wells. Investigators also obtained details of total well depths, static water levels, and pumping water levels (measured during active pumping). Wells 4 and 3 were relatively shallow, with static water levels of 21 and 22 feet, pumping levels of 25 and 26 feet, and total well depths of 43 and 46 feet, respectively; both began service in the 1930s, similar to the other wells in the system, which were also older.

While details around this event were being clarified and environmental testing was pending, an Internet-based questionnaire was designed to aid case-finding and assess potential

* https://www3.epa.gov/npdes/pubs/alagoons.pdf.

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exposures. A probable case was defined as a diarrheal illness of ≥2 days' duration with one or more additional signs or symptoms (nausea, vomiting, fever, chills, or headache) in a city A resident, with onset during February 28–March 23, 2017. A confirmed case was defined as a person meeting the probable case definition with either stool culture or PCR-positive results for *Campylobacter*, or a laboratory-confirmed probable illness in a nonresident who worked, dined, or shopped for groceries in city A. Among approximately 600 city A residents, 94 (16%) completed a questionnaire to report food consumption history, drinking water source, animal exposures, and symptoms. Among questionnaire respondents, 39 (41%) campylobacteriosis cases (six confirmed and 33 probable) were identified, with illness onset from February 28–March 21 (Figure); 25 (64%) cases occurred in females and 14 (36%) in males. The median age was 34.5 years (range = 1.5–85 years). Twelve (31%) patients sought medical care, and three (8%) were hospitalized; no deaths were reported.

Data analysis indicated a significant association between ill persons and consumption of untreated, unboiled municipal tap water (OR = 7.84; 95% CI = 1.69–36.36) (Table 2). Other exposures were assessed, including unpasteurized milk, animal contact, raw poultry, and ground beef, but none demonstrated a significant association with illness. Notably, no cases were reported among the approximately 28 residents of city A's only nursing home, which used city water but treated it with a reverse osmosis system.

Summary

What is already known about this topic?

Campylobacter has been implicated in outbreaks associated with poultry products, unpasteurized milk, and contaminated water sources.

What is added by this report?

A center pivot irrigation system intended to pump livestock waste water onto adjacent farmland in Nebraska malfunctioned, allowing excessive run off to collect in a road ditch near two wells that fed a municipal water supply, sickening 39 persons who consumed untreated city water. The use of culture-independent diagnostic tests facilitated case identification allowing for rapid public health response.

What are the implications for public health practice?

Access to clean water sources continues to be an important public health issue, and public health professionals should consider exposure to untreated water sources as a potential cause for *Campylobacter* outbreaks.

Public Health Response

Wells 3 and 4 were both permanently removed from service on March 16, and no additional illnesses were reported with

FIGURE. Confirmed (n = 6) and probable (n = 33) campylobacteriosis cases, by date of illness onset and well pumping date — Nebraska, 2017

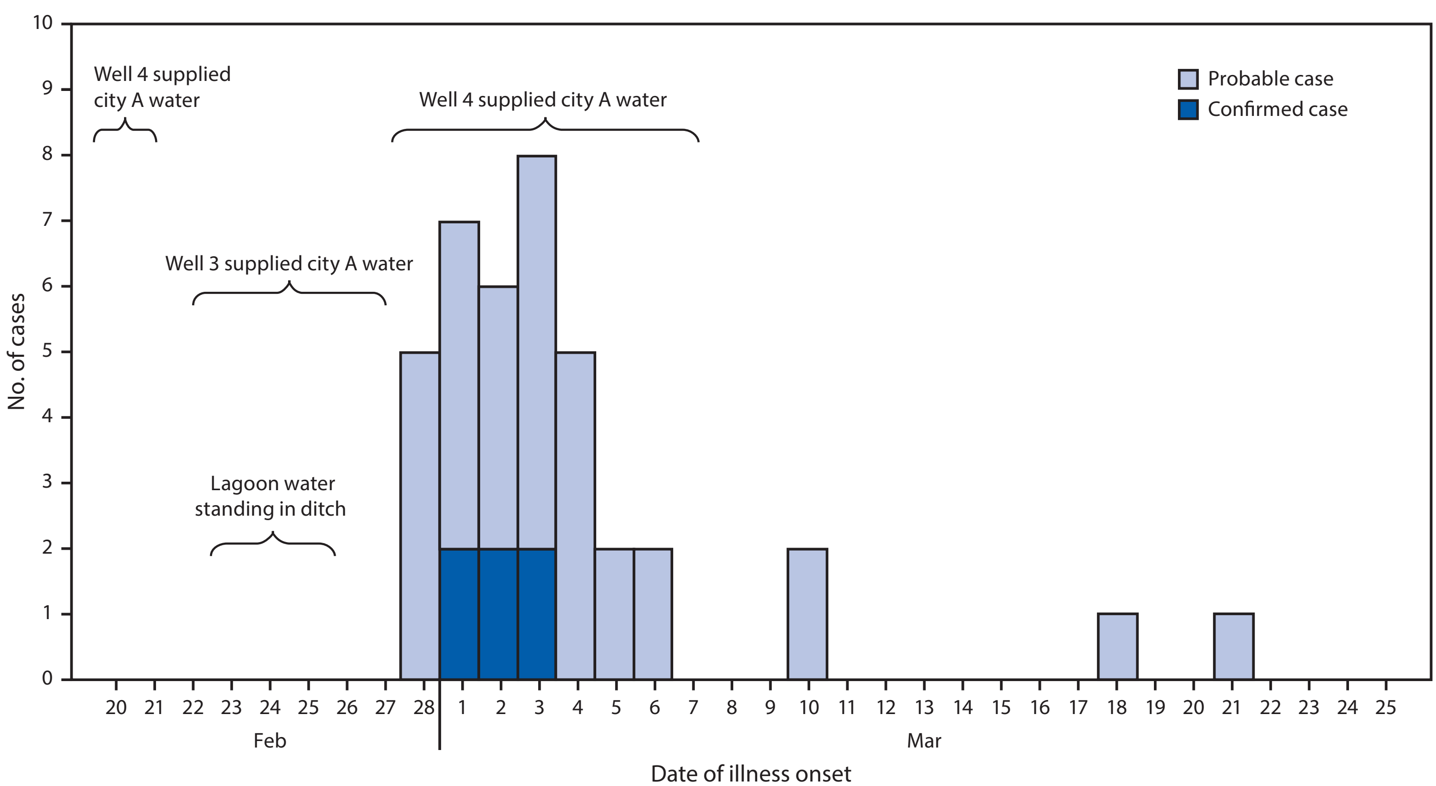

TABLE 1. Volume* and percentage of water pumped from each city A well, by week — Nebraska, 2017

Dates	Volume (%)				Total volume
	Well 2	Well 3†	Well 4†	Well 5	
February 15–21, 2017	278 (40.0)	0 (0)	417 (60.0)	0 (0)	**695**
February 22–27, 2017	282 (48.8)	296 (51.2)	0 (0)	0 (0)	**578**
February 28–March 7, 2017	327 (40.0)	0 (0)	491 (60.0)	0 (0)	**818**
March 8–13, 2017	207 (32.7)	0 (0)	0 (0)	426 (67.3)	**633**

* x 1,000 gallons.
† Well 3 and well 4 were adjacent to the ditch flooded by livestock wastewater (February 22–25).

TABLE 2. Potential exposures reported by survey respondents included for analysis (n = 94) in a community-wide campylobacteriosis investigation and corresponding odds ratios — city A, Nebraska, February 23–March 9, 2017

Exposure	No. (%)				OR (95% CI)*
	Cases (n = 38)		Controls (n = 56)		
	Exposed	Not exposed	Exposed	Not exposed	
City tap water	36 (94.7)	2 (5.3)	39 (69.6)	17 (30.4)	7.84 (1.69–36.36)
Unpasteurized milk	0 (0)	38 (100)	0 (0)	56 (100)	Undefined
Any chicken	12 (33.3)	24 (66.7)	24 (42.8)	32 (57.1)	0.66 (0.27–1.59)
Ground beef	24 (66.7)	12 (33.3)	33 (62.3)	20 (37.7)	1.21 (0.49–2.94)
Animal contact	19 (51.4)	18 (48.7)	40 (72.7)	15 (27.3)	0.39 (0.16–0.95)

Abbreviations: CI = confidence interval; OR = odds ratio.

onset after March 21. On April 25, NDHHS reclassified these wells to Emergency Status, meaning the well can only be pumped during a case of emergency (e.g., fire, drought, etc.) for nonpotable purposes. Furthermore, meetings were held with area stakeholders to present these findings as evidence to support the award of a planning grant to city A to explore options for a new, higher-volume well to be dug to an acceptable depth in a different location.

Discussion

This investigation implicates *Campylobacter jejuni* as the cause of this outbreak, most likely from a municipal water system contaminated by wastewater runoff from an adjacent concentrated animal feeding operation (*1*). In addition to environmental and statistical findings, this conclusion is consistent with prior investigations that demonstrate *Campylobacter* outbreaks of similar size are historically associated with contaminated water (*2*–*7*). Although laboratory testing of the water in this investigation did not yield any positive results, samples were not taken until long after the contamination event, and test results might have been affected by switches among wells supplying the system over time. These findings also suggest that routine coliform testing might not be a good indicator of the presence of *Campylobacter* species (*8*). Further, it is possible that *Campylobacter* in particular might be viable but not necessarily detectable by culture in water systems (*9*,*10*). The use of both culture and culture-independent diagnostic tests (PCR) were needed to detect the initial cluster of cases and early recognition of this outbreak. If culture alone had been used, only two cases would have been reported, one of which did not occur in a city A resident. Of those two culture-confirmed cases, one patient refused the interview and the other had typical *Campylobacter* exposures, such as live poultry, which might not have prompted such a rapid response. This investigation demonstrates the importance of considering exposure to untreated water sources as a potential cause for *Campylobacter* outbreaks. Including this risk factor in initial questioning could help to expedite outbreak investigations. Ultimately, early recognition and a coordinated response by several state and local agencies greatly facilitated this successful public health intervention.

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References

1. CDC. *Campylobacter* and drinking water from private wells. Atlanta, GA: US Department Health and Human Services, CDC; 2015. https://www.cdc.gov/healthywater/drinking/private/wells/disease/campylobacter.html
2. Ball A. Estimation of the burden of water-borne disease in New Zealand: preliminary report. Wellington, New Zealand: Ministry of Health; 2006. https://www.health.govt.nz/system/files/documents/publications/water-borne-disease-burden-prelim-report-feb07-v2.pdff

3. Clark CG, Price L, Ahmed R, et al. Characterization of waterborne outbreak-associated *Campylobacter jejuni*, Walkerton, Ontario. Emerg Infect Dis 2003;9:1232–41. https://doi.org/10.3201/eid0910.020584
4. DeFraites RF, Sanchez JL, Brandt CA, et al. An outbreak of *Campylobacter* enteritis associated with a community water supply on a U.S. military installation. MSMR 2014;21:10–5.
5. Jakopanec I, Borgen K, Vold L, et al. A large waterborne outbreak of campylobacteriosis in Norway: the need to focus on distribution system safety. BMC Infect Dis 2008;8:128. https://doi.org/10.1186/1471-2334-8-128
6. Richardson G, Thomas DR, Smith RMM, et al. A community outbreak of *Campylobacter jejuni* infection from a chlorinated public water supply. Epidemiol Infect 2007;135:1151–8. https://doi.org/10.1017/S0950268807007960
7. Tauxe RV. Epidemiology of *Campylobacter jejuni* infections in the United States and other industrialized nations. In: Nachamkin I, Tomkins S, Blaser M, eds. *Campylobacter jejuni*: current status and future trends. Washington, DC: American Society for Microbiology; 1992:9–19.
8. St-Pierre K, Lévesque S, Frost E, Carrier N, Arbeit RD, Michaud S. Thermotolerant coliforms are not a good surrogate for *Campylobacter spp*. in environmental water. Appl Environ Microbiol 2009;75:6736–44. https://doi.org/10.1128/AEM.00486-09
9. Jones DM, Sutcliffe EM, Curry A. Recovery of viable but non-culturable *Campylobacter jejuni*. J Gen Microbiol 1991;137:2477–82. https://doi.org/10.1099/00221287-137-10-2477
10. Rollins DM, Colwell RR. Viable but nonculturable stage of *Campylobacter jejuni* and its role in survival in the natural aquatic environment. Appl Environ Microbiol 1986;52:531–8.

Public Health Emergency Risk Communication and Social Media Reactions to an Errant Warning of a Ballistic Missile Threat — Hawaii, January 2018

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On January 13, 2018, at 8:07 a.m. Hawaii Standard Time, an errant emergency alert was sent to persons in Hawaii. An employee at the Hawaii Emergency Management Agency (EMA) sent the errant alert via the Wireless Emergency Alert (WEA) system and the Emergency Alert System (EAS) during a ballistic missile preparedness drill, advising persons to seek shelter from an incoming ballistic missile. WEA delivers location-based warnings to wireless carrier systems, and EAS sends alerts via television and radio (*1*). After 38 minutes, at 8:45 a.m., Hawaii EMA retracted the alert via WEA and EAS (*2*). To understand the impact of the alert, social media responses to the errant message were analyzed. Data were extracted from Twitter* using a Boolean search for tweets (Twitter postings) posted on January 13 regarding the false alert. Tweets were analyzed during two 38-minute periods: 1) early (8:07–8:45 a.m.), the elapsed time the errant alert circulated until the correction was issued and 2) late (8:46–9:24 a.m.), the same amount of elapsed time after issuance of the correction. A total of 5,880 tweets during the early period and 8,650 tweets during the late period met the search criteria. Four themes emerged during the early period: information processing, information sharing, authentication, and emotional reaction. During the late period, information sharing and emotional reaction themes persisted; denunciation, insufficient knowledge to act, and mistrust of authority also emerged as themes. Understanding public interpretation, sharing, and reaction to social media messages related to emergencies can inform development and dissemination of accurate public health messages to save lives during a crisis.

The rapid dissemination of public health messaging is a component of information management, one of the six core domains of public health preparedness (*3*). The information management domain addresses public health communication and includes two capabilities: 1) emergency public information and warning and 2) information sharing. Emergency public information and warning is an essential capability for state and local public health preparedness and consists of the ability to develop, coordinate, and disseminate information, alerts, warnings, and notifications to the public and incident management responders. The information sharing capability consists of the ability to conduct multijurisdictional, multidisciplinary exchange of health-related information and situational awareness data among all levels of the government and the private sector (*3*).

Using Sysomos† (version 1.47; Meltwater), an analysis of social media data from Twitter was performed by conducting a Boolean search to identify relevant tweets. The search used the terms "missile and Hawaii," "ballistic," "shelter," "drill," "threat," "alert," or "alarm" to identify tweets posted on the morning of January 13, 2018. Twitter data were used for this analysis because they are available in the public domain and easily accessible. Retweets (reposting the same tweet) and quote tweets (reposting the tweet with a comment at the top of the tweet) were excluded to limit the analysis to initial tweets.

All tweets were stratified into one of two periods. The early period consisted of tweets sent during the initial 38 minutes (8:07–8:45 a.m.), and the late period consisted of those sent in the 38 minutes after the false alarm retraction message was issued via EAS and WEA at 8:45 a.m. Tweets were coded using grounded theory, which is a systematic approach to analyze qualitative data and develop theories from those data (*4*). Themes were identified until theoretical saturation was reached. Atlas.ti§ software (version 8; Atlas.ti Scientific Software Development) was used for all exploratory qualitative analysis.

A total of 127,125 tweets were identified; after excluding 69,151 (54%) retweets and 43,444 (34%) quote tweets, 14,530 (11%) initial tweets remained for analysis. Among these, 5,880 (40%) were sent during the early period, and 8,650 (60%) were sent during the late period.

Four themes emerged from the Twitter data during the early period: 1) information processing; 2) information sharing; 3) authentication; and 4) emotional reaction. Information processing was defined as any indication of initial mental processing of the alert. Many information processing tweets dealt with coming to terms with the imminent missile threat (Table). Information sharing consisted of any attempt to disseminate the alert, often directed at other persons' Twitter handles (user names). One Twitter user shared a tweet with the U.S. Indo-Pacific Command, the Defense Intelligence Agency, and the White House National Security Council. Authentication involved any attempt to validate the alert. Finally, emotional reaction was the expression of shock, fear, panic, or terror.

* Twitter is an online social networking service where users can exchange short messages, or tweets, with one another.

† https://sysomos.com/.

§ https://atlasti.com/.

TABLE. Selected Twitter posts, by theme from the early* and late† periods in response to an errant warning of a ballistic missile threat — Hawaii, January 13, 2018

Period/Theme	Description	Examples
Early period		
Information processing	Indication of mental processing of the alert	"Sirens going off in Hawaii, ballistic missile threat issued. What's happening?" "Idk what's going on.. but there's a warning for a ballistic missile coming to Hawaii? [expletive deleted]"
Information sharing	Disseminating alert to others	"Just got an iPhone alert of inbound balistic [*sic*] missile in Hawaii. Said Not a Drill. @PacificCommand @DefenseIntel @WHNSC" "@ananavarro @TheRickWilson @AC360 Hawaii we all got emergency sirens on our phones ballistic missile inbound to Hawaii"
Authentication	Validating the alert	"Is this missile threat real?" "Where is news about the ballistic missile inbound to Hawaii?"
Emotional reaction	Expressing shock, fear, panic, or terror	"there's a missile threat here right now guys. I love you all and I'm scared as [expletive deleted]" "Woke up and started crying after seeing the Hawaii missile alert. Called my parents and balled [*sic*] my eyes out because I was so worried."
Late period		
Denunciation	Blaming the emergency warning and response	"How do you "accidentally" send out a whole [expletive deleted] emergency alert that says there's a missile coming to Hawaii and to take cover. AND TAKE THIRTY MINUTES TO CORRECT?!?" "To the person in #Hawaii who sent out that false alarm alert message about missile attack TO EVERY [expletive deleted] CELL PHONE...MOVE TO ANTARCTICA NOW! [emojis deleted] #that[expletive deleted]scaredeveryone @Hawaii_EMA"
Insufficient knowledge to act	Expressing lack of a response plan	"my friend & i were running around the hotel room freaking out because HOW DO WE TAKE SHELTER FROM A [expletive deleted] MISSILE?!" "Can you imagine waking up to an alert that says. "Take shelter there is a missile on the way" like Bruh. What shelter is there for a missile? That [expletive deleted] might as well say. "Aye Bruh. Missile on the way. Good luck"
Mistrust of authority	Doubting the emergency alert system and/or governmental response	"And now, should there be another ballistic missile threat, how can we trust it knowing the last one was a grave mistake???" "@Hawaii_EMA We all need to know who is behind this!!! . This is not a joke. . How can we trust the emergency alarm now? #hawaii #missile"

* 8:07–8:45 a.m. Hawaii Standard Time.
† 8:46–9:24 a.m. Hawaii Standard Time (additional themes identified in addition to those in the early period).

During the late period, the information sharing and emotional reaction themes persisted, and three new themes emerged: 1) insufficient knowledge to act; 2) denunciation; and 3) mistrust of authority (Table). These new themes are fundamentally different from those expressed during the early period and reflect reactions and responses to misinformation. Insufficient knowledge to act involved reacting to the lack of a response plan, particularly not knowing how to properly take shelter. Denunciation consisted of blaming the emergency warning and response, particularly criticizing the time it took to correct the alert. Finally, mistrust of authority involved doubting the emergency alert system or governmental response.

Discussion

Public health messaging during an emergency is complicated by how messages are perceived and interpreted by different persons. Emergency messages need to be coordinated across multiple platforms to ensure that accurate and timely information is appropriately disseminated to the target audience (*5*). Social media can be an effective tool to manage public health messaging during an emergency, and social media reactions to a perceived threat highlight the complexity of sharing critical information.

Reactions on social media reveal that some social media users lacked awareness about actions to take when faced with a nuclear threat. CDC developed guidance describing what persons in an affected area should do in response to a number of different types of emergencies, including a ballistic missile strike (*6*).

The Hawaii EMA's investigation of the errant emergency alert identified multiple contributing factors that led to the false alarm (*7*). The alarm notification occurred during a shift change, and there was a lack of understanding that the notification was meant to be a drill. The Federal Communications Commission (FCC) report noted that "the employee who triggered the false alert believed that the missile threat was real… In other words, the employee intended to initiate a real-world emergency alert based on that employee's mistaken belief that Hawaii had come under a ballistic missile attack. This fundamental misunderstanding played a critical role in the initiation of the false alert." (*8*). Furthermore, the exercise plans did not document a process for disseminating an all clear message (*7*).

As the situation unfolded, several public authorities posted information on Twitter stating that the alert was a false alarm. However, according to the FCC report, the established ballistic missile alert checklist did not include a step to notify the Hawaii EMA's public information officer responsible for communicating information to the public, media, other agencies, and other stakeholders during an incident. Finally, the FCC report noted that there was no credentialed two-person

Summary

What is already known about this topic?

Social media platforms are widely used to share information and disseminate alerts and warnings.

What is added by this report?

After an errant ballistic missile alert, social media reactions revealed how the public interprets, shares, and responds to information during an evolving threat. This knowledge can guide emergency risk communicators to develop timely and effective social media messages than can protect lives.

What are the implications for public health practice?

Social media can be an effective tool to send urgent messages during a public health emergency. Public health practitioners need to improve messaging during emergency risk communications to address the public's needs during each phase of an unfolding crisis to protect and save lives.

requirement to separately log in and approve the transmission of a ballistic missile alert message (*8*).

Missile alert exercises have not been conducted regularly in decades (*9*). A large proportion of the U.S. population alive today did not experience, or are too young to recall, exercises conducted to defend against threats faced by the United States during the Cold War era. The lack of a collective memory of missile alert drills coupled with the present-day ability to instantaneously share information through social media can affect societal reactions. To improve risk communication, additional research is needed to understand human reactions to emergencies in the social media age so that timely public health messages can be developed and disseminated to save lives.

The findings in this report are subject to at least two limitations. First, because the qualitative coding could be subjective, the sincerity and tone of the tweets could have been misinterpreted. Second, although quote tweets add to the original content through framing, labeling, magnifying, and elaborating on an initial tweet, they were excluded from this analysis to focus on the initial tweets. It is likely, however, that themes in quote tweets are similar to those in initial tweets.

Public information officers, communication specialists, and others responsible for planning and creating urgent communications during an emergency incident should consider the behavioral themes identified in this report when creating messages for public dissemination. Social media provides public health authorities with the capability to convey timely messages, address societal reactions during each phase of a crisis, and establish credibility to avoid mistrust and denunciation of a public health message. Alerts should include clear instructions for persons in the affected area to carry out during an emergency.

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All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. US Department of Homeland Security. Emergency alerts. Washington, DC: US Department of Homeland Security; 2018. https://www.ready.gov/alerts
2. Federal Communications Commission. Preliminary report: Hawaii Emergency Management Agency's January 13, 2018 false ballistic missile alert. Washington, DC: Federal Communications Commission; 2018. https://www.fcc.gov/document/presentation-preliminary-report-hawaii-false-emergency-alert
3. CDC. Public health preparedness capabilities: national standards for state and local planning. Atlanta, GA: US Department of Health and Human Services, CDC; 2018. https://www.cdc.gov/cpr/readiness/capabilities.htm
4. Chapman AL, Hadfield M, Chapman CJ. Qualitative research in healthcare: an introduction to grounded theory using thematic analysis. J R Coll Physicians Edinb 2015;45:201–5. https://doi.org/10.4997/JRCPE.2015.305
5. CDC. Crisis & emergency risk communication (CERC). Atlanta, GA: US Department of Health and Human Services, CDC; 2018. https://emergency.cdc.gov/cerc/index.asp
6. CDC. Emergency preparedness and response. Atlanta, GA: US Department of Health and Human Services, CDC; 2018. https://emergency.cdc.gov/radiation/index.asp
7. Oliveira, BE. False ballistic missile alert investigation for January 13, 2018. Honolulu, HI: Hawaii Emergency Management Agency; 2018. https://dod.hawaii.gov/wp-content/uploads/2018/01/report2018-01-29-181149.pdf
8. Federal Communications Commission. Report and recommendations: Hawaii Emergency Management Agency January 13, 2018 false alert. Washington, DC: Federal Communications Commission; 2018. https://docs.fcc.gov/public/attachments/DOC-350119A1.pdf
9. Brown J. A is for atom, b is for bomb: civil defense in American public education, 1948–1963. J Am Hist 1988;75:68–90. https://doi.org/10.2307/1889655

Leveraging Existing Birth Defects Surveillance Infrastructure to Build Neonatal Abstinence Syndrome Surveillance Systems — Illinois, New Mexico, and Vermont, 2015–2016

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Neonatal abstinence syndrome (NAS) is a drug withdrawal syndrome that can occur following prenatal exposure to opioids (*1*). NAS surveillance in the United States is based largely on diagnosis codes in hospital discharge data, without validation of these codes or case confirmation. During 2004–2014, reported NAS incidence increased from 1.5 to 8.0 per 1,000 U.S. hospital births (*2*), based on *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis codes identified in hospital discharge data, without case confirmation. However, little is known about how well these codes identify NAS or how the October 1, 2015, transition from ICD-9-CM to the tenth revision of ICD-CM (ICD-10-CM) codes affected estimated NAS incidence. This report describes a pilot project in Illinois, New Mexico, and Vermont to use birth defects surveillance infrastructure to obtain state-level, population-based estimates of NAS incidence among births in 2015 (all three states) and 2016 (Illinois) using hospital discharge records and other sources (varied by state) with case confirmation, and to evaluate the validity of NAS diagnosis codes used by each state. Wide variation in NAS incidence was observed across the three states. In 2015, NAS incidence for Illinois, New Mexico, and Vermont was 3.0, 7.5, and 30.8 per 1,000 births, respectively. Among evaluated diagnosis codes, those with the highest positive predictive values (PPVs) for identifying confirmed cases of NAS, based on a uniform case definition, were drug withdrawal syndrome in a newborn (ICD-9-CM code 779.5; state range = 58.6%–80.2%) and drug withdrawal, infant of dependent mother (ICD-10-CM code P96.1; state range = 58.5%–80.2%). The methods used to assess NAS incidence in this pilot project might help inform other states' NAS surveillance efforts.

Through a competitive application process, the March of Dimes, a nonprofit that works to improve the health of mothers and their babies (https://www.marchofdimes.org), in collaboration with CDC, awarded grants to CDC-funded, state-based birth defects programs in Illinois, New Mexico, and Vermont to adapt birth defects surveillance methodology to conduct active, population-based surveillance for NAS or passive case-finding with case confirmation. Each state defined a population-based 2015 birth cohort in which to identify infants with NAS; Illinois extended data collection to include a 2016 birth cohort. All three states used hospital discharge data to identify potential cases using infant ICD-9-CM diagnosis codes 779.5 (drug withdrawal syndrome in a newborn) and 760.72 (noxious influences affecting fetus or newborn via placenta or breast milk, narcotics) and ICD-10-CM codes P96.1 (drug withdrawal, infant of dependent mother) and P04.49 (newborn affected by maternal use of other drugs of addiction), as well as other infant and maternal diagnosis codes of interest to the state. Illinois used two additional data sources: 1) the Illinois birth defects registry's Adverse Pregnancy Outcomes Reporting System,* which collects information on infants born to Illinois residents with documented prenatal opioid exposure or withdrawal symptoms during their newborn hospitalizations; and 2) reports of infants with NAS scores >8 (typically on a scale of 0–37) from selected hospitals (*3*). Vermont also queried Medicaid claims data and Vermont's all-payer claims database, the Green Mountain Care Board's Vermont Health Care Uniform Reporting and Evaluation System (https://gmcboard.vermont.gov/health-data-resources/vhcures), for commercial claims data, as a part of a Birth Information Network established for surveillance for birth defects and other congenital conditions. In all three states, potential cases were identified among the 2015–2016 birth cohorts and then deduplicated.

States abstracted all available infant and maternal medical records of identified potential NAS cases to confirm the diagnosis.† A uniform clinical case definition, which expands on a previously published case definition (*4*), was then applied to potential cases (Box). The overall state-level confirmed population-based NAS incidence per 1,000 births (from all available data sources) and confirmed NAS incidence by data source were calculated. PPV was calculated by diagnosis code in medical records, defined as the number of confirmed NAS cases divided by the total number of potential NAS cases identified, multiplied by 100.

In 2015, NAS incidence was 3.0 per 1,000 births in Illinois, 7.5 in New Mexico, and 30.8 in Vermont (Table). In Illinois, data from hospital discharge data provided the highest estimate

* http://www.dph.illinois.gov/data-statistics/epidemiology/apors.

† Medical records of <2% of all potential cases were unable to be obtained for abstraction for reasons including that 1) the infant was born at an out of state hospital or 2) the infant was transferred out of state for treatment after birth.

BOX. Clinical case definition used to confirm cases of neonatal abstinence syndrome (NAS)* — Illinois, New Mexico, and Vermont, 2015 and Illinois, 2016

To meet the NAS clinical case definition, all of the following must occur:

1. Presence of a constellation of clinical signs consistent with NAS (i.e., a documented NAS score >8 [on a scale of 0–37]), not explained by another etiology or a documented infant diagnosis of NAS with pharmacologic treatment;
2. Documented history of maternal use during pregnancy of prescription or illicit drugs associated with NAS or laboratory confirmation of recent maternal drug use or fetal exposure to such drugs;
3. Severity of illness that resulted in a prolonged (>2 days) neonatal hospitalization.

* The original clinical case definition (https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6408a3.htm) was expanded for this project to include "or a documented infant diagnosis of NAS with pharmacologic treatment" in the first criterion.

of NAS incidence (2.7 per 1,000 births) compared with data from the Adverse Pregnancy Outcomes Reporting System (2.2) and from hospitals that provided NAS scores (0.4). In Vermont, Medicaid data[§] provided the highest estimate of NAS (62.3); incidence estimates based on hospital discharge data (29.6) and commercial claims data (1.6) were lower. The overall incidence of NAS in Illinois in 2016 remained at 3.0 per 1,000 births.

In all three states, the diagnosis codes with the highest PPVs for identifying confirmed cases of NAS, based on a uniform case definition were drug withdrawal syndrome in a newborn (ICD-9-CM code 779.5; state range = 58.6%–80.2%) and drug withdrawal, infant of dependent mother (ICD-10-CM code P96.1; range = 58.5%–80.2%) (Figure).

Discussion

No standardized way to conduct state-based NAS surveillance in the United States exists, and there is no standardized national surveillance system; most published NAS estimates are based on ICD-9-CM or ICD-10-CM diagnosis codes from hospital discharge data, without case confirmation, and few studies have validated these diagnosis codes for NAS surveillance (*5*,*6*). CDC has been supporting population-based surveillance for birth defects since 1967 to monitor the prevalence of birth defects and provide early warning of increases over time (*7*). In this pilot project, birth defects programs in Illinois, New Mexico, and Vermont demonstrated the feasibility of using existing birth defects surveillance methods and multiple data sources to obtain population-based estimates of NAS.

The wide variation in NAS incidence identified among the three states is consistent with the variation in state-specific prevalence of maternal opioid use disorder documented at delivery hospitalization (14.8 and 48.6 per 1,000 delivery hospitalizations in New Mexico and Vermont in 2014, respectively; data not available for Illinois) (*8*). Throughout 15 years of perinatal quality improvement, Vermont has been training personnel at birthing hospitals in the diagnosis and treatment of NAS, as well as in improving opioid agonist treatment capacity. Higher case ascertainment in states with enhanced procedures for identifying mothers with opioid use disorder and infants with NAS might, in turn, result in a higher NAS incidence.

Historically, NAS surveillance in Illinois has been conducted passively through hospital reports to the Adverse Pregnancy Outcomes Reporting System, and no published estimates in the literature of state-level NAS incidence currently exist. This report found that Illinois' passive surveillance methods, based on the Adverse Pregnancy Outcomes Reporting System (2.2 per 1,000 births), might underestimate the incidence of NAS. Illinois' NAS incidence from this report was lower than a published hospital discharge data–based regional estimate (6.9 per 1,000 births in Illinois, Indiana, Michigan, Ohio, and Wisconsin, in 2012) but similar to a 2013 estimate in Iowa (2.2) (*9*,*10*). Previous hospital discharge data–based estimates, without case confirmation, for New Mexico and Vermont were 8.5 and 33.3 per 1,000 births, respectively (*10*). These estimates are slightly higher than the estimates of confirmed NAS found in this report, suggesting that hospital discharge data, without case confirmation by medical record abstraction, might slightly overestimate the prevalence of NAS.

Among the diagnosis codes evaluated, infant drug withdrawal codes (ICD-9-CM code 779.5 and ICD-10-CM code P96.1) resulted in the highest PPVs. ICD-9-CM code 779.5 has been the most commonly used infant drug withdrawal code in the United States and is the most specific ICD-9-CM code for NAS (*2*,*9*,*10*). No change in PPV after transition from ICD-9-CM code 779.5 to ICD-10-CM code P96.1 was observed in two of the three states, providing a better understanding of how the transition might affect surveillance for NAS over time. A study of Tennessee Medicaid claims data reported a PPV of 91% for the ICD-9-CM drug withdrawal code (779.5) among 950 potential NAS cases during 2009–2011 and a PPV of 98.2% for the ICD-10-CM drug withdrawal code (P96.1) among 217 potential cases during 2016 (*6*). However, the higher PPVs from that study might result from the authors' use of a lower NAS threshold (NAS score >4) than that which

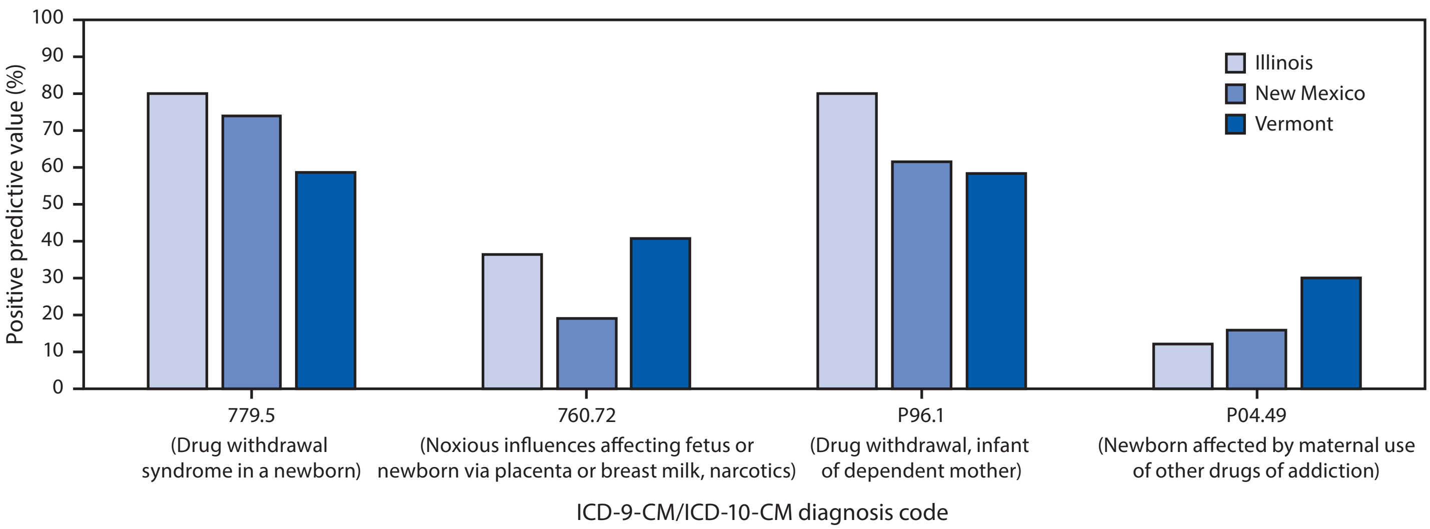
§ Vermont Medicaid and commercial estimates were calculated using denominators from the respective payers defined in birth file.

TABLE. Incidence of confirmed neonatal abstinence syndrome (NAS), by state and data source — Illinois, New Mexico, and Vermont, 2015 and Illinois, 2016

	Illinois	New Mexico	Vermont
Data source	No. of confirmed cases (cases per 1,000 births*)	No. of confirmed cases (cases per 1,000 births†)	No. of confirmed cases (cases per 1,000 births§)
2015¶	**474 (3.0)**	**194 (7.5)**	**160 (30.8)**
Hospital discharge data**	433 (2.7)	194 (7.5)	154 (29.6)
Adverse Pregnancy Outcomes Reporting System	351 (2.2)	—§§	—§§
Hospital-provided NAS score	70 (0.4)	—§§	—§§
Medicaid claims	—§§	—§§	144 (62.3)
Commercial claims	—§§	—§§	—†† (1.6)
2016¶	**470 (3.0)**	**—§§**	**—§§**
Hospital discharge data**	442 (2.9)	—§§	—§§
Adverse Pregnancy Outcomes Reporting System	336 (2.2)	—§§	—§§
Hospital-provided NAS score	9 (0.1)	—§§	—§§
Medicaid claims	—§§	—§§	—§§
Commercial claims	—§§	—§§	—§§

* Denominator = Illinois resident live births delivered in, or transferred to, a hospital in the Illinois Perinatal Network.
† Denominator = New Mexico resident births occurring in New Mexico.
§ Denominator = Vermont resident births occurring in Vermont from birth file. Denominators for Medicaid claims and commercial claims data defined by payer in birth file.
¶ Data sources were not mutually exclusive; therefore, the number of cases do not sum to the total.
** Hospital discharge data include all payer types, including Medicaid.
†† Numbers <11 from commercial claims data have been suppressed.
§§ Data not available.

FIGURE. Positive predictive value* of neonatal abstinence syndrome (NAS) diagnosis codes from the ninth and tenth revisions of *International Classification of Diseases, Clinical Modification* (ICD-9-CM and ICD-10-CM), by state and infant diagnosis code† — Illinois, New Mexico, and Vermont, 2015



* Positive predictive value calculated as follows: [(no. of confirmed NAS)/(no. of confirmed NAS + no. of not confirmed NAS)] x 100.
† ICD-9-CM diagnosis codes 779.5 and 760.72 were used before October 1, 2015; ICD-10-CM diagnosis codes P96.1 and P04.49 became effective October 1, 2015.

was used in the present study (NAS score >8). The variation in PPVs observed across states in this study might be caused by variability in coding and case definitions across states, hospitals, and providers. Hence, a careful evaluation of the use of NAS-related diagnosis codes in a particular state is important before relying on those codes for NAS surveillance.

The findings in this report are subject to at least three limitations. First, because this analysis was restricted to data from only three states, the findings are not necessarily generalizable to the rest of the United States. Second, the sensitivity of these diagnosis codes in identifying NAS cases could not be evaluated in this report because the actual frequency of NAS in each state is unknown. Finally, the case definition required a neonatal hospitalization of >2 days; therefore, infants discharged sooner would not meet the criteria. However, this would likely apply to only a small proportion of infants because the mean length

Summary

What is already known about this topic?

Neonatal abstinence syndrome (NAS) surveillance in the United States is based largely on diagnosis codes in hospital discharge data, without validation of these codes or case confirmation.

What is added by this report?

Estimates of NAS incidence during 2015 were 3.0 per 1,000 births for Illinois, 7.5 for New Mexico, and 30.8 for Vermont. Of the four diagnosis codes evaluated, those for infant drug withdrawal (779.5 and P96.1) had the highest positive predictive values for identifying confirmed NAS cases.

What are the implications for public health practice?

NAS surveillance based solely on diagnosis codes in hospital discharge data might slightly overestimate NAS incidence. These findings could help inform NAS surveillance in other states.

of stay for infants with NAS has been found to range from 14.9 to 16.6 days (*2*).

NAS surveillance based solely on diagnosis codes in hospital discharge data without case confirmation by medical record abstraction might slightly overestimate NAS incidence. This report provides more current, confirmed state-level, population-based estimates of NAS incidence in Illinois, New Mexico, and Vermont; demonstrates the feasibility of building on the experience of birth defects surveillance to conduct statewide NAS surveillance; and evaluates the use of diagnosis codes for identifying NAS cases. The lessons learned from this pilot project might help inform NAS surveillance efforts in other U.S. states or jurisdictions.

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References

1. Hudak ML, Tan RC; The Committee on Drugs; The Committee on Fetus and Newborn; American Academy of Pediatrics. Neonatal drug withdrawal. Pediatrics 2012;129:e540–60. https://doi.org/10.1542/peds.2011-3212
2. Winkelman TNA, Villapiano N, Kozhimannil KB, Davis MM, Patrick SW. Incidence and costs of neonatal abstinence syndrome among infants with Medicaid: 2004–2014. Pediatrics 2018;141:e20173520. https://doi.org/10.1542/peds.2017-3520
3. Zimmermann-Baer U, Nötzli U, Rentsch K, Bucher HU. Finnegan neonatal abstinence scoring system: normal values for first 3 days and weeks 5–6 in non-addicted infants. Addiction 2010;105:524–8. https://doi.org/10.1111/j.1360-0443.2009.02802.x
4. Lind JN, Petersen EE, Lederer PA, et al. Infant and maternal characteristics in neonatal abstinence syndrome—selected hospitals in Florida, 2010–2011. MMWR Morb Mortal Wkly Rep 2015;64:213–6.
5. Patrick SW, Dudley J, Martin PR, et al. Prescription opioid epidemic and infant outcomes. Pediatrics 2015;135:842–50. https://doi.org/10.1542/peds.2014-3299
6. Maalouf FI, Cooper WO, Stratton SM, et al. Positive predictive value of administrative data for neonatal abstinence syndrome. Pediatrics 2019;143:e20174183. https://doi.org/10.1542/peds.2017-4183
7. Correa A, Cragan JD, Kucik JE, et al. Reporting birth defects surveillance data 1968–2003. Birth Defects Res A Clin Mol Teratol 2007;79:65–186.
8. Haight SC, Ko JY, Tong VT, Bohm MK, Callaghan WM. Opioid use disorder documented at delivery hospitalization—United States, 1999–2014. MMWR Morb Mortal Wkly Rep 2018;67:845–9. https://doi.org/10.15585/mmwr.mm6731a1
9. Patrick SW, Davis MM, Lehmann CU, Cooper WO. Increasing incidence and geographic distribution of neonatal abstinence syndrome: United States 2009 to 2012. J Perinatol 2015;35:650–5. https://doi.org/10.1038/jp.2015.36
10. Ko JY, Patrick SW, Tong VT, Patel R, Lind JN, Barfield WD. Incidence of neonatal abstinence syndrome—28 states, 1999–2013. MMWR Morb Mortal Wkly Rep 2016;65:799–802. https://doi.org/10.15585/mmwr.mm6531a2

Notes from the Field

Lead and Cadmium Exposure in Electronic Recyclers — Two States, 2015 and 2017

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In 2012, CDC's National Institute for Occupational Safety and Health (NIOSH) became aware of the potential for occupational and take-home exposures to lead and cadmium in the electronics recycling industry (*1*) and contacted electronics industry stakeholders to discuss these exposures and provide information about NIOSH's ability to investigate workplace hazards. NIOSH subsequently received requests for health hazard evaluations to estimate employee exposures and to assess the potential for take-home contamination from lead and cadmium at facilities A and B, in two states. Both facilities refurbished electronics for resale, removed electronic components for reuse and resale, and recycled electronics for waste management. Facility A employees received and inventoried electronics for either recycling or refurbishment and resale. Recycled materials were disassembled by hand or shredded using an industrial shredder. Employees at facility B performed similar job tasks as did those at facility A, but did not shred electronic parts.

NIOSH evaluated facility A over 3 days in August 2015 and facility B over 2 days in July 2017. The evaluations included collection of 1) blood specimens to assess worker uptake of lead and cadmium; 2) personal air samples for assessment of lead and cadmium exposure; 3) questionnaire data concerning demographics, hand hygiene, and use of designated work clothing and personal protective equipment; 4) end-of-shift hand wipes to assess dermal exposure; and 5) surface wipe samples on nonprocessing surfaces, such as refrigerator handles and microwave control panels. All 15 employees at facility A and eight of 12 employees at facility B took part in the assessment (Table).

Only facility A employees were found to have blood lead levels above the CDC reference level of 5 μg/dL. Lead in personal air samples ranged from undetectable to 19 $\mu g/m^3$ (facility A), and from undetectable to 0.59 $\mu g/m^3$ (facility B); no samples at either facility exceeded the lead occupational exposure limit (OEL) of 50 $\mu g/m^3$.

Employee blood cadmium levels at both facilities were below the American Conference of Governmental Industrial Hygienists Biologic Exposure Index of 5 μg/L. One facility A employee's personal air cadmium exceeded the NIOSH-recommended OEL of 5 $\mu g/m^3$. Cadmium in personal air samples ranged from undetectable to 6.4 $\mu g/m^3$ (facility A) and from undetectable to 0.05 $\mu g/m^3$ (facility B). All participating employees at both facilities had both cadmium and lead on their hands after washing them at the end of their shift. Nonprocessing surfaces at facility A were contaminated with cadmium (nine of 12) and lead (11 of 12), as were surfaces at facility B (12 of 13 and 13 of 13, respectively).

Employees at both facilities reported wearing cloth, nitrile, and cut-resistant gloves. More facility B employees reported wearing gloves all or most of the time while at work than did facility A employees. All employees who wore gloves reused them. Employees were permitted to wear their work clothes and shoes home, and neither facility had capability for onsite laundering of work clothing. Employees at both facilities performed dry sweeping of surfaces, which can reaersolize metal-containing dust.

The findings of these health hazard evaluations confirm workplace exposures to lead and cadmium at these facilities and suggest that employees in shredding facilities might be at higher risk for exposure than are those at nonshredding facilities. The presence of lead and cadmium on the hands of employees at both facilities after end-of-shift handwashing highlights the potential for take-home contamination.

TABLE. Lead and cadmium testing results at two electronic recycling facilities — two states, 2015 and 2017

Characteristic	No. (%) Facility A* (15 employees)	No. (%) Facility B (12 employees)
Total participants	**15 (100)**	**8 (75)**
Male	12 (75)	7 (88)
Current smoker	6 (40)	5 (63)
Age (yrs), median (range)	37 (20–52)	32 (19–47)
Months working at facility, median (range)	15 (1–88)	27 (2–66)
Personal air results† exceeding OELs§		
Cadmium	1/45 (2)	0/16 (0)
Lead	0/45 (0)	0/16 (0)
Blood levels above reference ranges¶		
Cadmium	0/12 (0)	0/8 (0)
Lead	3/12 (25)	0/8 (0)
Positive end-of-shift dermal wipes		
Cadmium	14/14 (100)	8/8 (100)
Lead	14/14 (100)	8/8 (100)
Survey results of work practices		
Hand washing practiced all or most of time	12/15 (80)	6/8 (75)
Wear gloves all or most of the time	7/15 (47)	6/8 (75)
Wear work clothes home	12/15 (80)	7/8 (88)
Wear work shoes home	13/15 (87)	6/8 (75)

Abbreviation: OEL = occupational exposure limit.
* Some participants at facility A elected not to participate in every part of the evaluation.
† One sample per day over 3 days for facility A, and one sample per day over 2 days for facility B.
§ OELs over an 8-hour time-weighted average: lead = 50 $\mu g/m^3$; cadmium = 5 $\mu g/m^3$.
¶ Reference ranges: blood lead = 5 μg/dL; blood cadmium = 5 μg/L.

Adverse health effects have been reported in persons chronically exposed to lead even at levels at or below the CDC reference level of 5 μg/dL (*2*,*3*), as well as in those with long-term cadmium exposure (*4*). Electronic recycling employers should maintain written prevention programs that emphasize evaluating and reducing employees' exposure to hazardous metals. To further reduce exposure to hazardous metals, employers could implement strict handwashing policies with lead-removing soap to prevent take-home exposure, perform routine housekeeping to prevent build-up of hazardous heavy metals, and prohibit dry sweeping to prevent exposure to reaerosolized metals. Employers should ensure that employees wear gloves during disassembly and shredding of electronics, and if cut-resistant or cloth gloves are re-used, clean inner gloves should be provided. More detailed information in health hazard evaluation reports for facility A and facility B is available (*5*,*6*).

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All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. Newman N, Jones C, Page E, Ceballos D, Oza A. Investigation of childhood lead poisoning from parenteral take-home exposure from an electronic scrap recycling facility—Ohio, 2012. MMWR Morb Mortal Wkly Rep 2015;64:743–5.
2. Lanphear BP, Rauch S, Auinger P, Allen RW, Hornung RW. Low-level lead exposure and mortality in US adults: a population-based cohort study. Lancet Public Health 2018;3:e177–84. https://doi.org/10.1016/S2468-2667(18)30025-2.
3. National Toxicology Program. Health effects of low-level lead evaluation. Research Triangle Park, NC: US Department of Health and Human Services, National Institutes of Health, National Institute of Environmental Health Sciences; 2012. https://ntp.niehs.nih.gov/pubhealth/hat/noms/lead/index.html
4. Agency for Toxic Substances and Disease Registry. Toxicological profile for cadmium. Atlanta, GA: US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry; 2012. https://www.atsdr.cdc.gov/toxprofiles/TP.asp?id=48&tid=15
5. Beaucham CC, Ceballos D, Page EH, et al. Evaluation of exposure to metals, flame retardants, and nanomaterials at an electronics recycling company. Health hazard evaluation report 2015-0050-3308. Cincinnati, OH: US Department of Health and Human Services, CDC, National Institute for Occupational Safety and Health; 2018. https://www.cdc.gov/niosh/hhe/reports/pdfs/2015-0050-3308.pdf
6. Grimes GR, Beaucham CC, Ramsey JG. Evaluation of exposure to metals at an electronics recycling facility. Health hazard evaluation report 2016-0242-3315. Cincinnati, OH: US Department of Health and Human Services, CDC, National Institute for Occupational Safety and Health; 2018. https://www.cdc.gov/niosh/hhe/reports/pdfs/2016-0242-3315.pdf

Notes from the Field

Enteroinvasive *Escherichia coli* Outbreak Associated with a Potluck Party — North Carolina, June–July 2018

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On July 2, 2018, the North Carolina Division of Public Health was notified that approximately three dozen members of an ethnic Nepali refugee community had been transported to area hospitals for severe gastrointestinal illness after attending a potluck party on June 30. The North Carolina Division of Public Health partnered with the local health department and CDC to investigate the outbreak, identify the cause, and prevent further transmission. The investigation included molecular-guided laboratory testing of clinical specimens by CDC, which determined that this was the first confirmed U.S. outbreak of enteroinvasive *Escherichia coli* (EIEC) in 47 years.

A case was defined as the occurrence of diarrhea, vomiting, or fever ≥101°F (38.3°C) in a person who consumed food served at the party. Cases were identified through medical record review and retrospective cohort investigation with convenience sampling of party attendees. Among approximately 100 attendees, 52 met the case definition. Median age was 31 years (range = 3–76 years); 28 (54%) were hospitalized, including 13 (25%) with sepsis, and eight (15%) who were admitted to an intensive care unit. All patients recovered, and no secondary cases were identified.

Forty-nine persons, including 35 who were ill, were interviewed using a questionnaire to ascertain symptoms, recent travel, and food exposures. Participants also were provided with hand hygiene guidance. Among the 35 ill persons, 30 (86%) reported symptom onset on July 1, the day after the event (Figure). Median interval between eating and symptom onset was 20.5 hours (range = 1–45.5 hours). Overall, 33 (94%) ill persons experienced diarrhea, including 27 (77%), 19 (54%), and two (6%) who reported diarrhea that was watery, mucoid, or bloody, respectively. Thirty-two (91%) ill persons reported fever.

Participants reported eating chicken curry, vegetable curry, rice, lentil soup, fried bread, cold and hot salads, and cake; no imported foods were reported. No single food item was statistically significantly associated with illness; however, 37 persons reported eating chicken curry, and those who did had a 47% higher risk for illness than those who did not (risk ratio = 1.47; 95% confidence interval = 0.76–2.83). No food was available for testing. No interviewed person reported recent travel.

One hospital used a commercial multiplex polymerase chain reaction (PCR) gastrointestinal panel to test stool specimens from 25 patients; all tested positive for *Shigella*/EIEC (*Shigella* and EIEC are difficult to differentiate in clinical specimens, and the commercial panel does not distinguish between the two). Twenty-four of these specimens were submitted to the North Carolina State Laboratory of Public Health, and all were negative for *Shigella* and *E. coli* O157 by culture and for Shiga toxin genes stx_1 and stx_2 by PCR. MacConkey broths and stool specimens from 23 patients tested at the state laboratory were submitted to CDC, where a molecular-guided approach was used for the isolation of *Shigella*/EIEC. Colonies positive for *ipaH*, the target gene for *Shigella*/EIEC, were identified as EIEC O8:H19 in specimens from 12 patients.

This was the first confirmed outbreak of EIEC in the United States in 47 years, and the first report of EIEC serotype O8:H19. EIEC is a human enteric pathogen that causes dysentery and is transmitted through contaminated food or water and person-to-person contact (*1*). Infections occur most commonly in developing countries (*1*,*2*). The last known outbreak in the United States was reported in 1971 and was associated with imported cheese (*3*). More recently, contaminated vegetables were implicated in outbreaks in Italy in 2012 and the United Kingdom in 2014 (*4*,*5*). This investigation did not reveal the specific vehicle through which EIEC was transmitted.

Shigella was initially suspected based on preliminary PCR results and because EIEC infections are rarely identified. However, epidemiologic and clinical findings were inconsistent with previous *Shigella* outbreaks in North Carolina, which are typically associated with person-to-person transmission in child care settings and less severe clinical manifestations. Because of genetic and pathogenic similarities, EIEC and *Shigella* can be difficult to distinguish (*1*), and identification required a molecular-guided approach. This investigation highlights the importance of collaboration between epidemiologists and laboratorians when findings are inconsistent with the initial suspected etiology.

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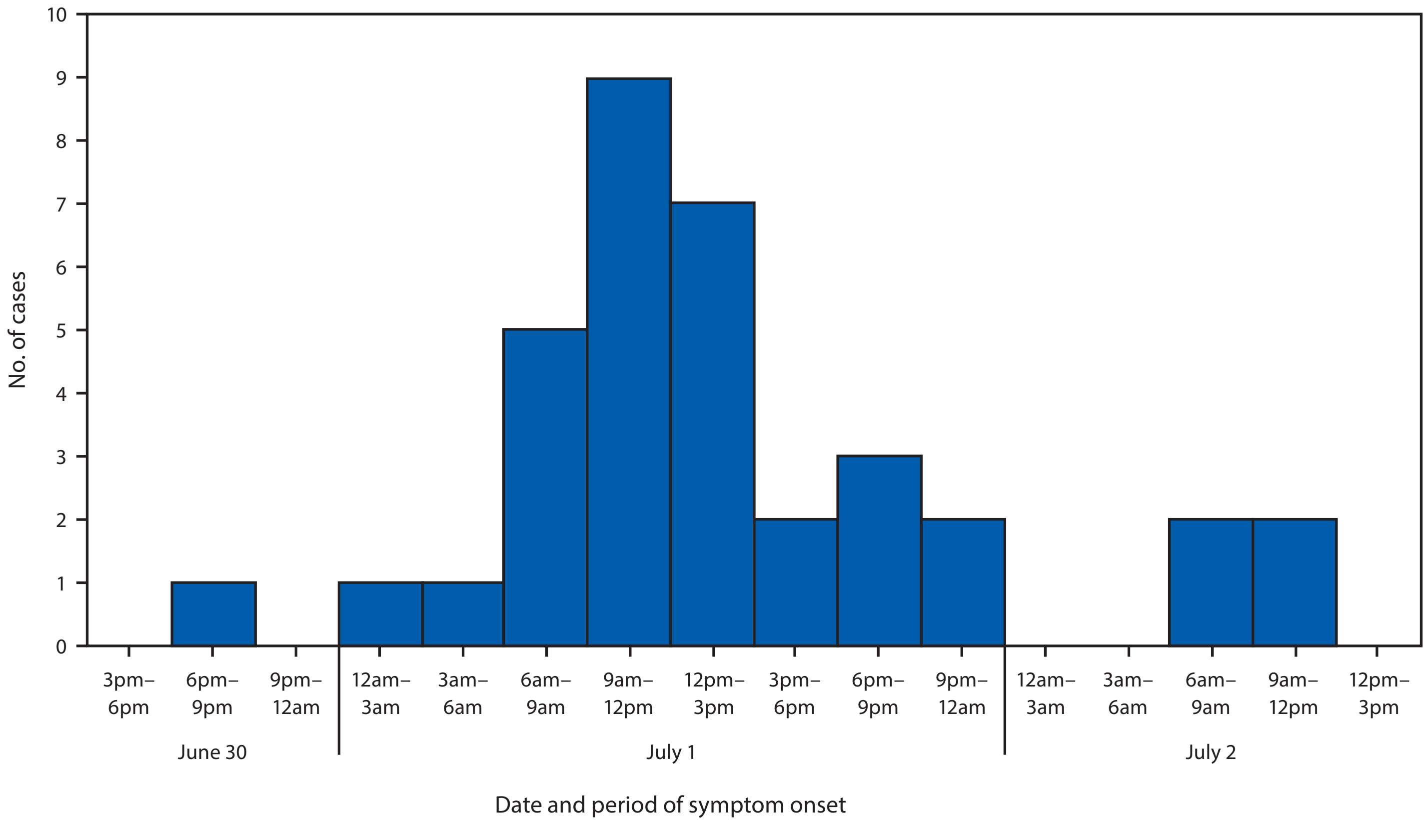
FIGURE. Number of enteroinvasive *Escherichia coli* cases (N = 35), by reported date and period of symptom onset — North Carolina, June 30–July 2, 2018



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References

1. Gomes TAT, Elias WP, Scaletsky ICA, et al. Diarrheagenic *Escherichia coli.* Braz J Microbiol 2016;47(Suppl 1):3–30. https://doi.org/10.1016/j.bjm.2016.10.015
2. Pasqua M, Michelacci V, Di Martino ML, et al. The intriguing evolutionary journey of enteroinvasive *E. coli* (EIEC) toward pathogenicity. Front Microbiol 2017;8:2390. https://doi.org/10.3389/fmicb.2017.02390
3. Marier R, Wells J, Swanson R, Callahan W, Mehlman I. An outbreak of enteropathogenic *Escherichia coli* foodborne disease traced to imported French cheese. Lancet 1973;302:1376–8. https://doi.org/10.1016/S0140-6736(73)93335-7
4. Escher M, Scavia G, Morabito S, et al. A severe foodborne outbreak of diarrhoea linked to a canteen in Italy caused by enteroinvasive *Escherichia coli*, an uncommon agent. Epidemiol Infect 2014;142:2559–66. https://doi.org/10.1017/S0950268814000181
5. Newitt S, MacGregor V, Robbins V, et al. Two linked enteroinvasive *Escherichia coli* outbreaks, Nottingham, UK, June 2014. Emerg Infect Dis 2016;22:1178–84. https://doi.org/10.3201/eid2207.152080

Notes from the Field

Human *Brucella abortus* RB51 Infections Caused by Consumption of Unpasteurized Domestic Dairy Products — United States, 2017–2019

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Since August 2017, CDC has confirmed three cases of brucellosis attributed to *Brucella abortus* cattle vaccine strain RB51 (RB51). Each case was associated with consumption of domestically acquired unpasteurized (raw) milk products (*1*). Patient symptoms varied and included fever, headache, overall malaise, and respiratory symptoms. In total, at least eight persons met the probable case definition of a clinically compatible illness epidemiologically linked to a shared contaminated source (*2*). In addition, hundreds of persons, from dozens of states, were potentially exposed to the contaminated raw milk products (*3*).

Consumption of raw milk products increases the risk for infection with pathogens such as *Escherichia coli*, *Campylobacter*, *Listeria*, and *Brucella* spp. Raw milk–related disease outbreaks occur more often in states with legalized raw milk sales (*4*). Approximately 75% of U.S. states have laws allowing various types of raw milk sales (*5*).

Brucellosis, caused by *Brucella* spp., is primarily an animal disease; however, exposure to infected animals or raw milk products can cause human disease. In humans, brucellosis is characterized by nonspecific symptoms, including fever, arthralgia, myalgia, and sweats; miscarriage and other sequelae can occur. Human brucellosis is rare in the United States, with 80–120 cases reported annually; most of these are associated with *Brucella* exposures abroad (CDC, unpublished data, 2019). The rarity of human brucellosis in the United States is mainly attributable to pasteurization and the successful U.S. State-Federal Cattle Brucellosis Eradication Program. As a result of the program's focus on disease surveillance and cattle vaccination, *B. abortus* in livestock has been eliminated, except in limited areas where disease reintroduction from infected wildlife occurs.

RB51 is a live, attenuated vaccine that has been used to vaccinate cattle against *B. abortus* in the United States since 1996. Although rare, it is possible for cattle to shed RB51 in their milk, even when vaccine label recommendations are followed (*6*). Consuming this raw milk can cause human infections, which, unlike infections caused by field *Brucella* strains, do not stimulate an antibody response detectable by commercially available serological assays and can be missed by tests normally used for diagnosis. In addition, RB51 is resistant to rifampin, a first-line antibiotic used to treat human brucellosis (*3*). When evaluating patients whose symptoms are consistent with brucellosis, clinicians should consider RB51 infection and inquire about raw milk consumption as part of the patient's exposure history (*3*).

Several actions could be considered to reduce the risk for raw milk–related RB51 human infections. CDC recommends that public health and regulatory authorities continue supporting pasteurization and consider further restricting the sale and distribution of raw milk and raw milk products in their jurisdictions.* States might explore options such as the United States Animal Health Association's recommendations that state animal health officials and cattle industry representatives evaluate the need for the RB51 vaccine in areas where *B. abortus* is not endemic in wildlife (*7*). Modifying current RB51 vaccine labels to include information about possible shedding in milk could also improve awareness. Finally, veterinarians and dairy farm owners need to be aware that RB51 vaccination might pose a risk when given to cows whose milk is intended to be consumed unpasteurized.

* https://realrawmilkfacts.com/PDFs/CDC-Raw-Milk-Letter-to-States-Territories.pdf.

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All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. Cossaboom CM, Kharod GA, Salzer JS, et al. Notes from the field: *Brucella abortus* vaccine strain RB51 infection and exposures associated with raw milk consumption—Wise County, Texas, 2017. MMWR Morb Mortal Wkly Rep 2018;67:286. https://doi.org/10.15585/mmwr.mm6709a4
2. CDC. Brucellosis reference guide: exposures, testing, and prevention. Atlanta, GA: US Department of Health and Human Services, CDC; 2017. https://www.cdc.gov/brucellosis/pdf/brucellosi-reference-guide.pdf
3. CDC. Third case of rifampin/penicillin-resistant strain of RB51 *Brucella* from consuming raw milk. Atlanta, GA: US Department of Health and Human Services, CDC; 2019. https://stacks.cdc.gov/view/cdc/62370
4. Mungai EA, Behravesh CB, Gould LH. Increased outbreaks associated with nonpasteurized milk, United States, 2007–2012. Emerg Infect Dis 2015;21:119–22. https://doi.org/10.3201/eid2101.140447
5. National Council of State Legislatures. State milk laws. Washington, DC: National Council of State Legislatures; 2016. http://www.ncsl.org/research/agriculture-and-rural-development/raw-milk-2012.aspx
6. Animal and Plant Health Inspection Service. Info sheet: *Brucella abortus* strain RB51 vaccine licensed for use in cattle. Riverdale, MD: US Department of Agriculture; 2018. https://www.aphis.usda.gov/animal_health/animal_dis_spec/cattle/downloads/rb51_vaccine.pdf
7. United States Animal Health Association. Resolution number 35: continued use of RB51 vaccine. Kansas City, MO: United States Animal Health Association; 2018. http://www.usaha.org/upload/Resolution/2018/Resolution_35_Use_of_RB51_Vacc.pdf

Erratum

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In Table 2 of the report “Suicide Rates by Major Occupational Group — 17 States, 2012 and 2015,” on page 1255, some percentages were calculated using records with Standard Occupational Classification (SOC) codes as the denominator rather than all suicide decedents aged 16–64 years. The corrected Table 2 follows. The ranking of occupational groups by suicide rate is unaffected by this correction. On page 1254, the first sentence of the second complete paragraph should have read, “In both 2012 and 2015, the largest percentage of male suicides (**15%–16%** of decedents) occurred among those in the Construction and Extraction group (SOC 47) (Table 2); the largest percentage of female suicides in both years occurred among decedents with unpaid occupations (29%). The largest percentage of female suicides among classifiable occupations occurred in the Office and Administrative Support group (SOC 43) in both years (**9% and 10%**).”

TABLE 2. Number and percentage of suicide decedents* in Standard Occupational Classification (SOC) major group, by year and sex — National Violent Death Reporting System, 17 states,† 2012 and 2015

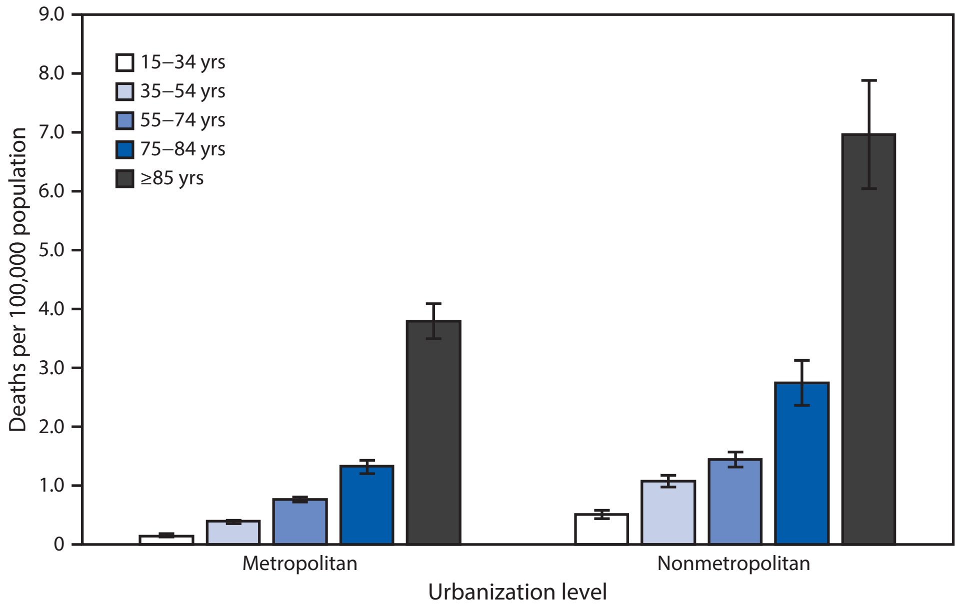
		Male		Female	
SOC code	Occupational group	2012 no. (%)	2015 no. (%)	2012 no. (%)	2015 no. (%)
11	Management	534 (7)	611 (7)	117 (5)	118 (4)
13	Business and Financial Operations	155 (2)	145 (2)	81 (3)	84 (3)
15	Computer and Mathematical	208 (3)	237 (3)	22 (1)	32 (1)
17	Architecture and Engineering	172 (2)	167 (2)	10 (<1)	15 (1)
19	Life, Physical, and Social Science	56 (1)	52 (1)	15 (1)	21 (1)
21	Community and Social Service	41 (1)	48 (1)	39 (2)	40 (1)
23	Legal	54 (1)	49 (1)	34 (1)	29 (1)
25	Education, Training, and Library	91 (1)	87 (1)	82 (3)	84 (3)
27	Arts, Design, Entertainment, Sports, and Media	140 (2)	186 (2)	54 (2)	76 (3)
29	Health Care Practitioners and Technical occupations	145 (2)	169 (2)	220 (9)	225 (8)
31	Health Care Support	35 (<1)	34 (<1)	97 (4)	124 (5)
33	Protective Service	232 (3)	226 (3)	29 (1)	32 (1)
35	Food Preparation and Serving Related	214 (3)	301 (3)	112 (4)	154 (6)
37	Building and Grounds Cleaning and Maintenance	316 (4)	315 (4)	36 (1)	46 (2)
39	Personal Care and Service	81 (1)	85 (1)	98 (4)	102 (4)
41	Sales and Related	555 (7)	553 (6)	170 (7)	212 (8)
43	Office and Administrative Support	244 (3)	260 (3)	234 (9)	268 (10)
45	Farming, Fishing, and Forestry	68 (1)	71 (1)	7 (<1)	5 (<1)
47	Construction and Extraction	1,216 (15)	1,404 (16)	12 (<1)	17 (1)
49	Installation, Maintenance, and Repair	549 (7)	621 (7)	8 (<1)	NR (<1)
51	Production	605 (7)	679 (8)	64 (3)	81 (3)
53	Transportation and Material Moving	736 (9)	817 (9)	52 (2)	39 (1)
NA	Military	228 (3)	203 (2)	15 (1)	13 (<1)
NA	Unpaid	822 (10)	913 (11)	724 (29)	795 (29)
NA	Insufficient Information to Classify Occupation	651 (8)	425 (5)	177 (7)	123 (4)

Abbreviations: NA = not assigned; NR = not reported because cell size <5.
* Aged 16–64 years; column percentages do not sum to 100% because of rounding.
† Alaska, Colorado, Georgia, Kentucky, Maryland, Massachusetts, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, Virginia, and Wisconsin.

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Death Rates* Attributed to Excessive Cold or Hypothermia† Among Persons Aged ≥15 Years, by Urbanization Level§ and Age Group — National Vital Statistics System, 2015–2017



* Crude rate of deaths per 100,000 population; 95% confidence intervals indicated by error bars.

† Deaths attributed to excessive cold or hypothermia were identified using the *International Classification of Diseases, Tenth Revision* underlying cause of death code X31 (Exposure to excessive natural cold) or multiple cause-of-death code T68 (Hypothermia).

§ Urbanization level is based on the Office of Management and Budget's February 2013 delineation of metropolitan statistical areas (MSA), in which each MSA must have at least one urbanized area of ≥50,000 inhabitants. Areas with <50,000 inhabitants are grouped into the nonmetropolitan category.

During 2015–2017, death rates attributed to excessive cold or hypothermia increased steadily with age among those aged ≥15 years in both metropolitan and nonmetropolitan counties. The rate for persons aged ≥85 years reached 3.8 deaths per 100,000 in metropolitan counties and 7.3 in nonmetropolitan counties. The lowest rates were among those aged 15–24 years (0.2 in metropolitan counties and 0.5 in nonmetropolitan counties). In each age category, death rates were lower in metropolitan counties and higher in nonmetropolitan counties.

Source: National Center for Health Statistics, National Vital Statistics System, Mortality Data 2015–2017.

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