

## Spinal and Paraspinal Infections Associated with Contaminated Methylprednisolone Acetate Injections — Michigan, 2012–2013

As of May 6, 2013, Michigan had reported 167 (52%) of the 320 paraspinal or spinal infections without meningitis associated with the 2012–2013 fungal meningitis outbreak nationally. Although the index patient (1) had a laboratory-confirmed *Aspergillus fumigatus* infection, the fungus most often identified, including in unopened vials of methylprednisolone acetate (MPA), remains *Exserohilum rostratum*, a common black mold found on plants and in soil (2). Exposures have occurred through epidural, paraspinal, peripheral nerve, and intra-articular injection with MPA from contaminated lots compounded by the New England Compounding Center in Framingham, Massachusetts. The Michigan Department of Community Health and CDC conducted case ascertainment to describe epidemiologic and clinical characteristics of Michigan patients and to determine factors that might have contributed to the high percentage of spinal and paraspinal infections reported from Michigan. A distinct epidemiologic or clinical difference was not observed between patients with paraspinal or spinal infection with and without meningitis. Lengthy periods (range: 12–121 days) were observed from date of last injection with contaminated MPA to date of first magnetic resonance imaging (MRI) finding indicative of infection. Clinicians should continue to maintain a higher index of suspicion for patients who received injections with contaminated MPA but have not developed infection.

Since the first case was reported in Tennessee on September 18, 2012 (1), as of May 6, 2013, the outbreak of fungal meningitis and other fungal infections had resulted in 741 reported cases and 55 deaths in 20 states. The total case count in Michigan was 261 and included 16 deaths. During the first 4 weeks of the outbreak, September 7–October 5, 2012, nearly all of the reported cases nationally met the CDC case definition solely for meningitis. However, at outbreak week 5, certain states, including Michigan, began reporting cases of localized spinal and paraspinal infections, including epidural abscesses, phlegmon, arachnoiditis, discitis, or vertebral osteomyelitis. As of

May 6, 2013, these localized infections, without concurrent meningitis, had accounted for 320 (43%) of the 741 total reported cases. Michigan had reported the highest number of spinal and paraspinal infection cases (167), accounting for 52% of the 320 cases reported nationally. Michigan also had reported an additional 43 spinal and paraspinal infection cases with meningitis.

### Case Definition

For this outbreak, the CDC case definition for spinal or paraspinal infection was as follows: osteomyelitis, abscess, or other infection (e.g., soft-tissue infection) of unknown etiology, in the spinal or paraspinal structures at or near the site of injection after epidural or paraspinal injection on or after May 21, 2012. A paraspinal injection included but was not limited to spinal facet joint injection, sacroiliac joint injection, and spinal or paraspinal nerve root or ganglion block (5). In Michigan, even when no clinical signs or symptoms were evident, MRI sometimes was conducted to detect localized infections.

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Laboratory tests, including direct microscopy, culture, nucleic acid amplification, and histopathology, were used to identify the specific pathogen causing infection. However, no gold standard for case identification exists; whereas an MRI finding might be falsely positive because of nonspecific enhancement, laboratory detection of the pathogen might be falsely negative. As a consequence, the rate of laboratory pathogen detection and surgical intervention overall has been low among patients with MRI suggestive of infection.

## Case Characteristics

Four pain management facilities in Michigan received 2,225 of the approximately 17,000 vials of MPA that came from the three contaminated lots\* distributed nationally (3). One lot has been associated with a significantly greater risk for fungal infection compared with the other two lots (4). All three contaminated lots have been recalled by the New England Compounding Center.

A total of 2,537 nonperipheral joint injections of contaminated MPA from the three lots were administered to residents of Michigan; however, some patients received multiple injections, resulting in a lower count (1,791) of exposed persons. As of January 29, 2013, epidemiologic or clinical data were available for 180 patients in Michigan: 141 of the 165 patients (167 as of May 6) with spinal or paraspinal infections alone and 39 of the 43 patients who had spinal or paraspinal infections

along with meningitis (Table 1). One patient with a spinal infection also had a peripheral joint infection. Of the 180 patients, 160 (89%) received care for their infections from St. Joseph Mercy Hospital in Ann Arbor. The 160 patients treated for their infections at St. Joseph included 113 (80%) who had diagnoses only of spinal or paraspinal infection and not meningitis. Four (2%) of the 180 patients died. Two deaths occurred among patients with diagnosed spinal or paraspinal infections and meningitis, and two deaths occurred among patients with spinal or paraspinal infections alone. The specific causes of death are being investigated.

Overall, the distribution by sex (Table 1) and age of patients with spinal or paraspinal infection with and without meningitis was not significantly different. Median age for all patients was 65 years: 67 years for those with meningitis, and 65 years for those without meningitis. Signs and symptoms at the time of initial diagnosis were available for 178 of the 180 patients (Table 1), including 139 of the 141 patients with spinal or paraspinal infections without meningitis and all 39 patients with spinal or paraspinal infections and meningitis. The most common symptom reported among patients with spinal or paraspinal infections and meningitis was headache (28 [72%]), followed by nausea or vomiting (18 [46%]) and back pain (18 [46%]). Among the 139 patients with spinal or paraspinal infections without meningitis, the most common reported symptom was back pain (98 [71%]), followed by headache (49 [35%]) and neck pain or stiff neck (29 [21%]).

\*Lot numbers 05212012@68, 06292012@26, and 08102012@51.

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**TABLE 1. Number and percentage of patients with fungal spinal or paraspinal infections with and without meningitis who received contaminated methylprednisolone acetate injections, by sex and clinical characteristics — Michigan, 2012**

Characteristic	All patients (N = 180)		Spinal or paraspinal infections with meningitis (n = 39)		Spinal or paraspinal infections without meningitis (n = 141)	
	No.	(%)	No.	(%)	No.	(%)
<b>Sex</b>						
Male	75	(42)	14	(36)	61	(43)
Female	105	(58)	25	(64)	80	(57)
<b>Signs and symptoms of spinal or paraspinal infection</b>	<b>(n = 178)</b>		<b>(n = 39)</b>		<b>(n = 139)</b>	
Fever/chills	13	(7)	6	(15)	7	(5)
Headache	77	(43)	28	(72)	49	(35)
Slurred speech	2	(1)	0	—	2	(1)
Confusion	8	(4)	4	(10)	4	(3)
Light sensitivity	21	(12)	12	(31)	9	(6)
Nausea/vomiting	39	(22)	18	(46)	21	(15)
Neck pain/stiff neck	42	(24)	13	(33)	29	(21)
Back pain	116	(65)	18	(46)	98	(71)
Leg pain	12	(7)	0	—	12	(9)
Urinary retention	4	(2)	0	—	4	(3)
Urinary incontinence	2	(1)	0	—	2	(1)
Ataxia	1	(1)	0	—	1	(1)
Visual disturbance	6	(3)	3	(8)	3	(2)
Numbness	10	(6)	2	(5)	8	(6)
Meningeal signs*	7	(4)	6	(15)	1	(1)
Laboratory confirmation of fungal infection†	57	(32)	20	(51)	37	(26)

\* Including nuchal rigidity, Kernig sign, and Brudzinski sign.

† Confirmation by culture, polymerase chain reaction, or histopathology.

Median cerebrospinal fluid white cell count at diagnosis among patients with spinal and paraspinal infections and meningitis was 194/ $\mu$ L (range: 6–15,400/ $\mu$ L), similar to the findings reported nationally (6). As of January 29, 2013, fungal infection had been laboratory-confirmed among 57 (32%) of 178 patients, with additional results pending (Table 1).

Among the 180 patients with epidemiologic or clinical data available, 31 (79%) of the 39 with spinal or paraspinal infection and meningitis had received only one contaminated injection, and seven (18%) had received two injections (Table 2). Among those with spinal or paraspinal infection without meningitis, 93 (66%) of 141 had received one injection, and 26 (18%) had received two injections. Among patients with available information, median number of days from the last injection to the first positive MRI finding was 50 days (range: 12–121 days) for all patients with a spinal or paraspinal infection, 52 (range: 12–121) for patients who received one injection, and 43 (range: 18–116) for patients who received one or more injections (Table 2). Median number of days from the first positive lumbar puncture finding to the first positive MRI finding for patients with spinal and paraspinal infections and meningitis was 21 days (Table 2).

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#### Editorial Note

Several reasons might explain the higher number and percentage of patients with spinal or paraspinal fungal infection in Michigan compared with other states. Only 13% of potentially contaminated vials were shipped to the state, yet, as of May 6, 2013, 52% of paraspinal and spinal infections, and 29% of deaths had been reported in Michigan. Early experience with patients who received diagnoses of localized spinal or paraspinal infections despite minimal or no new symptoms and no prior diagnosis of meningitis prompted clinicians at St. Joseph Mercy

**TABLE 2. Number and percentage of contaminated spinal or paraspinal injections and number of days from 1) last injection to first positive MRI finding and from 2) first positive lumbar puncture finding to first positive MRI finding, among 180 patients with available information — Michigan, 2012**

Clinical course	All patients (N = 180)		Spinal or paraspinal infections with meningitis (n = 39)		Spinal or paraspinal infections without meningitis (n = 141)	
	No.	(%)	No.	(%)	No.	(%)
<b>Contaminated spinal or paraspinal injections</b>						
≥1*	18	(10)	1	(3)	17	(12)
1	124	(69)	31	(79)	93	(66)
2	33	(18)	7	(18)	26	(18)
3	4	(2)	0	—	4	(3)
4	1	(1)	0	—	1	(1)
<b>No. days from last injection to first positive MRI finding overall</b>						
No. patients with available information	158		38		120	
Median	50		46		51	
Range	12–121		23–116		12–121	
<b>No. days from last injection to first positive MRI finding for patients who received 1 injection</b>						
No. patients with available information	122		31		91	
Median	52		48		54	
Range	12–121		23–75		12–121	
<b>No. days from last injection date to first positive MRI finding for patients who received ≥1 injection</b>						
No. patients with available information	36		7		29	
Median	43		46		42	
Range	18–116		30–116		18–109	
<b>No. days from first positive lumbar puncture finding to first positive MRI finding overall</b>						
No. patients with available information	39		39		—	
Median	21		21		—	
Range†	-6–61		-6–61		—	
<b>No. days from first positive lumbar puncture finding to first positive MRI finding for patients who received 1 injection</b>						
No. patients with available information	31		31		—	
Median	19		19		—	
Range†	-1–61		-1–61		—	
<b>No. days from first positive lumbar puncture finding to first positive MRI finding for patients who received ≥1 injection</b>						
No. patients with available information	7		7		—	
Median	25		25		—	
Range†	-6–49		-6–49		—	

**Abbreviation:** MRI = magnetic resonance imaging.

\* Received at least one contaminated injection, but total number of contaminated injections have not been determined.

† Negative numbers indicate patients who had an MRI finding “suggestive of infection” before they were administered a lumbar puncture.

Hospital to use an expanded diagnostic approach, offering spinal MRIs to patients who had received injections but had no symptoms of infection. Repeat MRIs were offered every 2–3 weeks to all persons who had received injections whether or not they had previously undergone care. Thus, increased case finding might partly explain the increased spinal or paraspinal infections in Michigan. Another possible explanation for the higher number of spinal or paraspinal infections could be that the vials of MPA shipped to Michigan had higher levels of contamination with fungus, predisposing patients to localized infection or tissue reaction. Among Michigan patients who had localized infections without meningitis, 80% received contaminated MPA injections from Michigan Pain Specialists, which was shipped 400 5-mL vials from the lot associated with an increased risk for infection. The 400 5-mL vials represented the largest shipment of 5-mL vials to any single state. Alternatively, a specific injection technique (a transforaminal

rather than translaminar approach) preferred by clinicians at St. Joseph Mercy Hospital might, in part, explain the difference.

Among patients exposed to contaminated MPA through injection, early recognition and initiation of therapy might reduce the risk for associated complications, including stroke and death (3,4), and remains crucial to management of this outbreak. CDC guidelines (7) urge clinicians to maintain a higher index of suspicion for patients who have unrecognized localized spinal or paraspinal infections, to embark on an assertive clinical management approach, and to follow up with these patients. However, because voriconazole and liposomal amphotericin B, the most widely used therapies, can both be toxic and MRI findings might be equivocal, a strategy of waiting 2–4 weeks for repeat MRIs while watching for signs of progression might be a reasonable alternative to immediate initiation of treatment. MRI screening also should be considered for patients without new signs or symptoms of infection but whose baseline symptoms persist, because distinguishing

**What is known on this topic?**

The 2012–2013 outbreak of fungal meningitis and associated localized spinal or paraspinal infections was caused by contaminated methylprednisolone acetate injections manufactured by the New England Compounding Center in Framingham, Massachusetts. *Exserohilum rostratum*, a common black mold found on plants and in soil, remains the most common cause of infection nationally.

**What is added by this report?**

As of May 6, 2013, Michigan had reported 167 (52%) of the 320 spinal or paraspinal infections without meningitis associated with the outbreak nationwide. Analysis of the Michigan cases did not find a distinct epidemiologic or clinical difference between patients with paraspinal and spinal infections with meningitis and patients with paraspinal and spinal infections without meningitis. Additionally, the findings indicated a wide range (12–121 days) in the number of days from the last injection with contaminated MPA to the first MRI finding indicative of infection. Finally, no correlation was found between the number of injections of contaminated MPA received by patients and the likelihood of infection.

**What are the implications for public health practice?**

Patients with diagnosed spinal or paraspinal infections might not have signs and symptoms greater than their baseline levels, and the lack of a gold standard in diagnosing fungal infection in such patients might present a challenge. Clinicians should be aware that some infections have surfaced long after the contaminated injections and, therefore, a higher index of suspicion for patients who received injections with contaminated MPA should be maintained.

patients' chronic pain from pain resulting from spinal or paraspinal infections is challenging.

This outbreak has presented multiple challenges, including unknown incubation periods, a broader spectrum of clinical presentations than initially anticipated, latent disease, and a wide range in the number of days from the last contaminated

injection to the first positive MRI finding, especially among patients with spinal or paraspinal infections without meningitis. Expanded MRI screening efforts might lead to additional diagnoses and improve case ascertainment, but such efforts should be considered along with the unknown balance of risks and benefits in treating patients on the basis of MRI findings alone.

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## Assessment of Risk for Exposure to Bats in Sleeping Quarters Before and During Remediation — Kentucky, 2012

Bats are a reservoir for rabies viruses and have been identified as the most common source of human rabies infections acquired in the United States. The last human rabies fatality from a bat exposure reported in a Kentucky resident occurred in 1996 (1). In July 2012, the Kentucky Department for Public Health (KDPH) was advised of multiple potential bat exposures following efforts to eliminate a bat colony from a volunteer facility. Bats had routinely been sighted in a brick building in eastern Kentucky that had been used as sleeping quarters by an organization that, since 1999, had hosted thousands of children and adults who performed stints of volunteer work over the course of several days. To assess the risk for bat exposure, KDPH and CDC interviewed 257 (94%) of the 273 volunteers and staff members who had slept in the facility in 2012. As a result of that assessment, 48 (19%) persons were identified as potentially exposed, and 16 (33%) of the 48 were recommended to receive rabies postexposure prophylaxis (PEP), including three persons categorized as at high risk and 13 as at moderate risk for exposure. This report highlights the need for guidelines for appropriate remediation of bat infestation and public health investigations of potential mass bat contacts.

### Assessment of Risk for Bat Exposure

On July 28, 2012, KDPH was notified about potential mass bat contacts at a volunteer facility in eastern Kentucky that occurred before and during remediation efforts to rid the facility of bats. The facility had housed 273 volunteers and staff members during 2012 and was reported to have had a roosting colony of 200–300 big brown bats (*Eptesicus fuscus*). Bats had been seen in and around the facility since 1999; however, an increase in human contact with the bats during 2012 prompted concern. An investigative team including KDPH and CDC staff members developed a telephone survey to assess the risk for bat exposure among those who had slept in the facility. Data collected during the risk assessment included dates slept in the building, rooms slept in, level of bunk slept on, and whether the volunteer or staff member saw bats inside or outside of the building. For observed bats, respondents were asked about the apparent health status of the bats (healthy, injured or ill, or dead), direct contact with bats (bitten, scratched, or touched the bat near the head or mouth), whether they had awakened in a room with a bat, and whether they recalled seeing a bat make contact with other persons who were sleeping. In addition, persons were asked whether they considered themselves to be

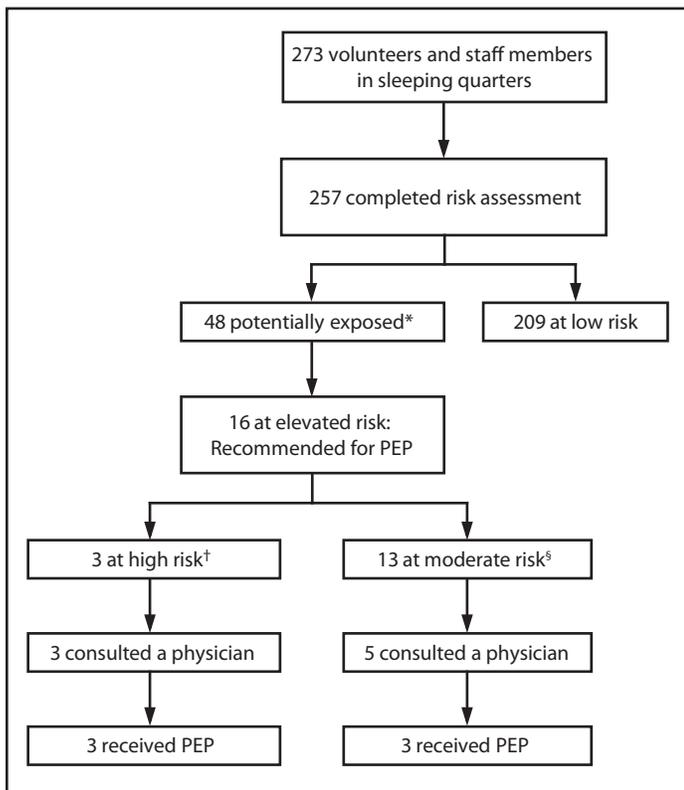
heavy sleepers, slept with skin exposed, or used any medications, drugs, or alcohol that might cause impaired sensation during sleep (2).

A total of 257 (94%) of 273 volunteers and staff members who had slept in the building in 2012 completed a risk assessment and were categorized as at low, moderate, or high risk for bat exposure. Persons who had no indication of potential bat contact were categorized at low risk, and no additional follow-up was recommended for them. Persons were considered at moderate risk if they slept in a room on the night a bat was sighted and had a self-reported condition that could decrease their awareness of bat contact while sleeping. Persons at high risk were those thought to have had direct skin contact with a bat and who could not definitively rule out a bite or scratch. Persons found to be at moderate or high risk for rabies exposure were referred to their medical provider to discuss PEP.

The 257 persons ranged in age from 13 to 87 years, with a median age of 21 years. Bats were sighted in sleeping quarters on 13 nights during June 19–July 24, 2012. Based on these sightings, 48 (19%) persons were considered potentially exposed to bats while they slept (Figure). Sixteen (6.3%) of the 48 persons were determined to be at elevated risk for rabies exposure: three at high risk and 13 at moderate risk. All 16 were advised to receive PEP. Two of the three persons at high risk for exposure had held a bat without gloves. The third person at high risk was awakened when he rolled onto a bat in his bed and caught bats on two separate occasions without the use of gloves. Another person petted a bat (away from the head or mouth) and was considered at moderate risk. No persons reported bat bites or scratches. Males (four of 118) were more likely than females (none of 139) to have touched a bat. A follow-up survey found that all persons at high risk received PEP, and three of 13 at moderate risk received PEP. Because one volunteer at low risk received PEP, KDPH decided to additionally survey 32 randomly selected persons at low risk who had not been recommended for PEP. Of the 29 who responded to the survey, five consulted a physician, and none received PEP.

In rare instances, clinical rabies has developed  $\geq 1$  year after exposure (3). Therefore, persons who slept at the facility in 2011 were mailed a notification letter from the volunteer organization with information regarding bats in the facility, basic information on bats and rabies, and directions to seek medical evaluation for risk assessment if they had direct contact with a bat or other exposure concerns. Persons who had stayed at the facility before 2011 were not contacted.

**FIGURE. Assessment of risk for bat exposure in a volunteer facility — Kentucky, 2012**



**Abbreviation:** PEP = postexposure prophylaxis.

\* Had direct contact with a bat or slept in a room where a bat was sighted.

† Had direct contact with the mouth or head of a bat or was unable to rule out such contact.

§ Had direct contact with a bat other than the mouth or head or was unable to rule out contact with bat while sleeping.

## Remediation of Bat Infestation

The volunteer organization hired pest control experts on July 9, 2012, 19 days before KDPH was notified of the infestation and human contact. Pest control professionals reported finding a colony of 200–300 big brown bats roosting above the ceiling tiles of the volunteer and staff member sleeping quarters. Initial remediation began on July 10 and consisted of installing netting and wire mesh over building entry points above the female sleeping quarters. On four of the subsequent five nights, bats were seen in the female sleeping quarters. On July 16, external entry points above the male sleeping quarters were blocked with wire mesh and netting, but bats were sighted in male sleeping quarters on six of the subsequent seven nights. Outside netting likely allowed the majority of bats to exit the building, whereas others ventured into the sleeping quarters looking for additional exits. The pest control team removed and replaced 60% of the ceiling tiles because of guano and debris, a possible indicator of the longevity and size of the building infestation.

### What is already known on this topic?

Bats are a known reservoir for rabies in the United States. Each year an average of two or three persons die from rabies, and in recent years all domestically acquired human rabies cases have resulted from contact with a rabid bat. Currently no recommendations specifically address mass human exposure to bats, a scenario where levels of potential bat exposure might be difficult to assess.

### What is added by this report?

This report found that 19% of persons assessed for bat exposure had slept in a room where a bat was sighted at night, and 33% of those persons reported direct contact with a bat. Seventy-four percent of indoor bat sightings occurred in the 2 weeks the facility remained open following the start of bat exclusion efforts. All three participants assessed at highest risk for bat exposure received postexposure prophylaxis (PEP) in response to this investigation, and three of 13 persons at moderate risk adhered to a recommendation to receive PEP. No persons staying at the facility developed rabies.

### What are the implications for public health practice?

Each year, millions of persons sleep in seasonal housing quarters and year-round homes in areas with large bat populations. This report describes what appears to have been an effective method for conducting risk assessments on a large transient population exposed to bats in sleeping quarters. Knowledge of the risks for human-bat contact and appropriate bat exclusion efforts could reduce the potential for human-bat contact.

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### Editorial Note

Rabies is an acute, progressive, and fatal encephalitis transmitted to humans by a bite from a rabid animal (4) or infectious saliva or neural tissue that comes in direct contact with open wounds or mucous membranes. Since 2002, the source of infection for 21 of 24 domestic human rabies cases was determined to be a bat (1). In 2011, 7% of bats tested in Kentucky were positive for rabies virus (KDPH, unpublished data, 2012). Rabies PEP is recommended for anyone who has been bitten or scratched by a bat (if the bat is unavailable for testing). In addition, thorough risk assessment should be conducted and PEP considered in situations where a bat is identified in direct proximity to a person who cannot be reasonably sure a bat bite or scratch did not occur, such as

someone awaking in a room with a bat or having a condition that might decrease awareness of a bat contact (2). Bat bites and scratches typically are not severe, and history of a known bite was not elicited in approximately half of the reported cases of human rabies attributable to bats (3,5). Bites or scratches from animals should be washed with soap and water immediately, and consultation should be sought with a health-care provider or local health department for any potential exposure to bats.

In this report, repeated bat sightings in sleeping quarters by both staff members and volunteers points to a significant lack of public awareness of the risks of bat exposure and a clear need for education of the general public and organizations that provide sleeping quarters in areas with large bat populations. Educational materials were distributed, informing staff members that bats are a reservoir for rabies and any future bat sightings inside facilities should be reported to the local health department to allow for safe capture and testing of bats and remediation of the facility, as necessary.

Mass bat exposure events should be reported immediately to public health officials, who can advise on proper exclusion techniques, which might vary based on the characteristics of the facility, bat colony size, and season. A common exclusion method is to place netting over building entry points to allow exit of bats, but prevent reentry. Juvenile bats are often unable to exit through this netting, and therefore often explore alternative exits, so exclusion timing should take into account the age

of the bat population. CDC recommends that steps be taken when excluding bats from group lodging facilities to ensure that the risk for human contact is not increased for those residing or working in the building as a result of bats seeking alternate exit routes during the process. Although no formal guidelines or validated assessments are available that specifically discuss mass exposure to bats, the assessments of risk categorization conducted during this investigation, along with similar recent investigations in the United States (6), could significantly improve the efficiency and outcomes of future investigations.

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## Microbes in Pool Filter Backwash as Evidence of the Need for Improved Swimmer Hygiene — Metro-Atlanta, Georgia, 2012

Filters physically remove contaminants, including microbes, from water in treated recreational water venues, such as pools. Because contaminants accumulate in filters, filter concentrates typically have a higher density of contamination than pool water. During the 2012 summer swimming season, filter concentrate samples were collected at metro-Atlanta public pools. Quantitative polymerase chain reaction (qPCR) assays were conducted to detect microbial nucleic acid. *Pseudomonas aeruginosa* was detected in 95 (59%) of 161 samples; detection indicates contamination from the environment (e.g., dirt), swimmers, or fomites (e.g., kickboards). *P. aeruginosa* detection underscores the need for vigilant pool cleaning, scrubbing, and water quality maintenance (e.g., disinfectant level and pH) to ensure that concentrations do not reach levels that negatively impact swimmer health. *Escherichia coli*, a fecal indicator, was detected in 93 (58%) samples; detection signifies that swimmers introduced fecal material into pool water. Fecal material can be introduced when it washes off of swimmers' bodies or through a formed or diarrheal fecal incident in the water. The risk for pathogen transmission increases if swimmers introduce diarrheal feces. Although this study focused on microbial DNA in filters (not on illnesses), these findings indicate the need for swimmers to help prevent introduction of pathogens (e.g., taking a pre-swim shower and not swimming when ill with diarrhea), aquatics staff to maintain disinfectant level and pH according to public health standards to inactivate pathogens, and state and local environmental health specialists to enforce such standards.

During June–August 2012, county (Cobb, DeKalb, Fulton, and Gwinnett) and state environmental health specialists collaborated with CDC to collect filter concentrates at a convenience sample of public pools. The study protocol entailed collecting a 1-liter filter backwash\* sample 30 seconds after the start of backwash flow and immediately neutralizing any free chlorine (the form of chlorine that inactivates pathogens), using 2.5 mL of a 10% sodium thiosulfate solution. Additionally, the following data were collected using a standardized form: type of filter media; pool location (i.e., indoor versus outdoor), setting (i.e., membership/club, municipal, or waterpark), and primary patron designation (i.e., adults and children versus primarily

children); type of disinfectant used; visible signage instructing patrons not to swim when ill with diarrhea; estimated number of swimmers in the past week; and estimated number of days since last filter backwash. No pool identifiers were collected.

During December 2012–March 2013, nucleic acid was extracted from each sample (1), and qPCR assays (Table 1), were conducted to detect nucleic acid of *E. coli*, *P. aeruginosa*, *Giardia intestinalis*, *Cryptosporidium* spp., *E. coli* O157:H7 (a pathogenic toxin-producing *E. coli*), noroviruses GI and GII, and adenovirus.† Detection of a study microbe was defined as a qPCR cycle threshold§ value <40.

All but one of the pool filters in the study were rapid sand filters; the remaining filter used diatomaceous earth. At least one of the assayed microbes was detected in 121 (75%) of 161 filter backwash samples collected. *P. aeruginosa* was detected in 95 (59%) samples. *E. coli* was detected in 93 (58%) samples. *P. aeruginosa* and *E. coli* were both detected in 67 (42%) samples. *G. intestinalis* was detected in two samples. *Cryptosporidium* spp. were detected in one sample. Neither *E. coli* O157:H7, norovirus GI, norovirus GII, nor adenovirus was detected in any of the samples. The proportion of samples positive for *E. coli* significantly ( $p \leq 0.05$ ) differed between membership/club and municipal pools (Table 2). The proportion of samples positive for *P. aeruginosa* significantly differed between venues treated with traditional chlorine products combined with ultraviolet light disinfection versus those treated with saltwater-generated free chlorine.¶ Most (71% [10 of 14]) pools with saltwater-generated free chlorine were located outdoors.

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† CDC does not recommend testing the water or the filter backwash of treated recreational water venues (e.g., pools and hot tubs/spas) for microbes unless the venue is at least suspected to be associated with a waterborne disease outbreak. Maintaining proper disinfectant level and pH should prevent transmission of chlorine-susceptible pathogens.

§ Cycle threshold value is the fractional cycle number reported by real-time PCR instruments indicating the point at which the fluorescence associated with a positive DNA amplification reaction increases beyond the threshold associated with negative reactions.

¶ In saltwater pools, an electric current is passed through the water to generate free chlorine from sodium chloride. This free chlorine is the same as the free chlorine generated when traditional chlorine products are added to pool water.

\*Contaminants accumulate in pool filters, leading to a decrease in water flow through the filter. Consequently, filters need to be regularly backwashed. Backwashing reverses the direction of the flow of water so that contaminants trapped by the filter are dislodged and discharged to waste.

TABLE 1. Target genes and molecular testing methodologies, by microbe — metro-Atlanta, Georgia, December 2012–March 2013

Microbe	Target gene	Molecular testing methodology
<i>Escherichia coli</i>	<i>uid A</i>	Sandhya S, Chen W, Mulchandani A. Molecular beacons: a real-time polymerase chain reaction assay for detecting <i>Escherichia coli</i> from fresh produce and water. <i>Anal Chim Acta</i> 2008;614:208–12.
<i>Pseudomonas aeruginosa</i>	<i>ecfX</i>	Amagliani G, Parlani ML, Brandi G, Sebastianelli G, Stocchi V, Schiavano GF. Molecular detection of <i>Pseudomonas aeruginosa</i> in recreational water. <i>Int J Environ Health Res</i> 2012;22:60–70.
<i>Giardia intestinalis</i>	18S rRNA	Manuscript submitted for publication.
<i>Cryptosporidium</i> spp.	18S rRNA	Jothikumar N, da Silva AJ, Moura I, Qvarnstrom Y, Hill VR. Detection and differentiation of <i>Cryptosporidium hominis</i> and <i>Cryptosporidium parvum</i> by dual TaqMan assays. <i>J Med Microbiol</i> 2008;57:1099–105.
<i>E. coli</i> O157:H7	<i>eae</i>	Sharma VK, Dean-Nystrom EA. Detection of enterohemorrhagic <i>E. coli</i> O157:H7 by using a multiplex real-time PCR assay for genes encoding intimin and Shiga toxins. <i>Vet Microbiol</i> 2003;93:247–60.
Noroviruses GI and GII	ORF1-ORF2	Hill VR, Mull B, Jothikumar N, Ferdinand K, Vinje J. Detection of GI and GII noroviruses in ground water using ultrafiltration and TaqMan real-time RT-PCR. <i>Food Environ Virol</i> 2010;2:218–24.
Adenovirus	Hexon	Jothikumar N, Cromeans TL, Hill VR, Lu X, Sobsey MD, Erdman DD. Quantitative real-time PCR assays for detection of human adenoviruses and identification of serotypes 40 and 41. <i>Appl Environ Microbiol</i> 2005;71:3131–6.

TABLE 2. Microbes in filter backwash samples from public pools (n = 161), by selected characteristics — metro-Atlanta, Georgia, 2012

Characteristic	Backwash samples qPCR-positive for <i>Pseudomonas aeruginosa</i> (n = 95)			Backwash samples qPCR-positive for <i>Escherichia coli</i> (n = 93)			Backwash samples qPCR-positive for any study microbes (n = 121)		
	No.	(%)	p-value	No.	(%)	p-value	No.	(%)	p-value
<b>Location</b>									
Indoor (n = 57)	28	(49)		33	(58)		39	(68)	
Outdoor (n = 104)	67	(64)	0.0591	60	(58)	0.9802	82	(79)	0.1432
<b>Setting</b>									
Membership/Club*† (n = 89)	55	(62)		44	(49)		64	(72)	
Municipal‡ (n = 37)	22	(59)	0.8063	26	(70)	0.0321	30	(81)	0.2814
Waterpark¶ (n = 35)	18	(51)	0.2909	23	(66)	0.1017	27	(77)	0.5529
<b>Primary patron designation</b>									
Adults and children (n = 145)	85	(59)		81	(56)		106	(73)	
Primarily children (n = 15)	10	(67)	0.5458	11	(73)	0.1926	14	(93)	0.1181**
<b>Type of disinfectant</b>									
Chlorine (traditional), UV* (n = 21)	9	(43)		13	(62)		15	(71)	
Chlorine (traditional), ozone (n = 1)	1	(100)	NC	1	(100)	NC	1	(100)	NC
Chlorine (traditional) (n = 125)	74	(59)	0.1618	73	(58)	0.7626	94	(75)	0.7131
Chlorine (saltwater generated) (n = 14)	11	(79)	0.0365	6	(43)	0.2678	11	(79)	0.7115**
<b>Visible signage instructing patrons not to swim when ill with diarrhea</b>									
Yes (n = 35)	23	(66)		19	(54)		28	(80)	
No (n = 125)	72	(58)	0.3876	74	(59)	0.6025	93	(74)	0.4952

Abbreviations: qPCR = quantitative polymerase chain reaction; UV = ultraviolet light disinfection; NC = not calculated because of limited data.

\* Referent group.

† Membership/Club: any venue with limited access (e.g., apartment complexes and health and fitness centers).

‡ Municipal: any city- or county-owned venue not classified as a waterpark.

¶ Waterpark: any venue with interactive water features, shallow-depth pool, or spray feature.

\*\* Two-sided Fisher's exact test used because 25% of the cells have expected counts <5. Otherwise, chi-square test was used.

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### Editorial Note

The detection of *E. coli* in over half of filter backwash samples indicates that swimmers frequently introduced fecal material into pools and thus might transmit infectious pathogens to

others. The risk for transmission and recreational water illness (RWI)\*\* increases if swimmers introduce feces when ill with diarrhea (Box). A single diarrheal contamination incident can introduce  $10^7$ – $10^8$  *Cryptosporidium* oocysts (2) into the water, a quantity sufficient to cause infection if a mouthful of water from a typical pool is ingested (3). Additionally, each person has an average of 0.14 grams of fecal material on their perianal surface that could rinse into the water (4) if swimmers fail to take a pre-swim shower with soap. The 1) frequent occurrence of fecal contamination of pools documented in this study and 2) marked increase in the incidence of RWI outbreaks, which is driven by the substantially increasing incidence of acute gastrointestinal illness outbreaks associated with pools and caused by pathogens transmitted by the fecal-oral route (particularly the extremely chlorine-tolerant parasite, *Cryptosporidium*) (5), underscore the need for improved swimmer hygiene (e.g., taking a pre-swim shower and not swimming when ill with diarrhea). This study also found that the proportion of samples positive for *E. coli* significantly differed between membership/club and municipal pools. This finding might reflect differences in the number of swimmers who are either diapered children or children learning toileting skills.

Additionally, more than half of filter backwash samples were positive for *P. aeruginosa*. The detection of this ubiquitous microbe could reflect environmental (e.g., dirt or pool fill water), swimmer (e.g., fecal material or skin), or fomite (e.g., kickboards) contamination. Once in a pool, *P. aeruginosa* inhabits and amplifies in biofilms on moist or submerged surfaces, such as pool walls, plumbing, and filters. Further investigation is needed to better characterize *P. aeruginosa* contamination of pools and its contributing factors. *P. aeruginosa* can cause RWI (e.g., otitis externa or dermatitis) outbreaks when adequate disinfection is not consistently maintained (5). The proportion of samples positive for *P. aeruginosa* significantly differed between venues treated with traditional chlorine products combined with ultraviolet light disinfection versus those treated with saltwater-generated free chlorine. The reason for this association is unclear but might reflect differences in swimmers or pool location, age, or design. Pool operator vigilance (e.g., cleaning, scrubbing surfaces, and maintaining water quality [e.g., disinfectant level and pH]) and enforcement of such public health standards by state and local environmental health specialists can minimize *P. aeruginosa* amplification and thus prevent a negative impact on swimmer health.

\*\* RWIs are caused by infectious pathogens transmitted by ingesting, inhaling aerosols of, or having contact with contaminated water in swimming pools, hot tubs/spas, water parks, interactive fountains, lakes, rivers, and oceans. RWIs also can be caused by chemicals in the water or chemicals that volatilize from the water and cause indoor air quality problems.

#### BOX. Swimmer hygiene recommendations

##### **Keep feces and urine out of the water.**

- Don't swim when you have diarrhea.
- Shower with soap before you start swimming.
- Take a rinse shower before you get back into the water.
- Take bathroom breaks every 60 minutes.
- Wash your hands after using the toilet or changing diapers.

##### **Check the chlorine level and pH before getting into the water.**

- Pools: proper chlorine level (1–3 mg/L or parts per million) and pH (7.2–7.8) maximize pathogen inactivation.
- Most superstores, hardware stores, and pool-supply stores sell pool test strips.

##### **Don't swallow the water you swim in.**

##### **Take some extra steps if you are the parent of a young child.**

- Take children on bathroom breaks every 60 minutes or check diapers every 30–60 minutes.
- Change diapers in the bathroom or diaper-changing area and not at poolside where pathogens can rinse into the water.

Additional information available at <http://www.cdc.gov/healthyswimming>.

The findings in this report are subject to at least four limitations. First, the pools sampled in this study are a convenience sample of pools in metro-Atlanta, and thus study findings cannot be generalized to pools in metro-Atlanta or beyond. However, the incidence of RWI outbreaks of acute gastrointestinal illness throughout the United States suggests that swimmers frequently introduce fecal material and pathogens into recreational water throughout the country. Second, qPCR results alone cannot be used to determine whether the detected pathogens were viable or infectious or determine the level of swimmer risk; qPCR detects viable microbes as well as those inactivated by disinfection. Of note, no RWI outbreaks associated with pools were detected in Georgia in 2012. Third, pool operators were asked to estimate the number of swimmers in the past week and number of days since last filter backwash; however, the data were deemed unreliable and thus could not be used to characterize the relationship between either of these factors and the detection of microbes in filter backwash samples. Finally, *E. coli* are found in fecal material from warm-blooded animals, not just humans. However, the *E. coli* detected in the pool filter backwash samples is most likely of

**What is already known on this topic?**

Since 1978, the incidence of recreational water illness (RWI) outbreaks of acute gastrointestinal illness has substantially increased, driving the marked increase in incidence of RWI outbreaks overall. A major contributing factor is poor swimmer hygiene (i.e., diarrheal incidents) in the implicated pools. A 2006 survey of metro-Atlanta public pools focused on the detection of chlorine-tolerant parasites, *Cryptosporidium* spp. and *Giardia* in filter backwash samples.

**What is added by this report?**

In this survey, pool filter backwash samples were collected at metro-Atlanta public pools during the 2012 summer swim season; qPCR assays were conducted to detect *Escherichia coli* (a fecal indicator), *Pseudomonas aeruginosa*, *Cryptosporidium* spp., *Giardia intestinalis*, *E. coli* O157:H7 (a pathogenic toxin-producing *E. coli*), norovirus genogroups I and II, and adenovirus. *E. coli* was detected in 93 (58%) of 161 samples collected. qPCR results alone cannot be used to determine whether the detected microbes were viable or infectious or determine the level of swimmer risk; qPCR detects viable microbes as well as those inactivated by disinfection.

**What are the implications for public health practice?**

The detection of *E. coli* in more than half of pool filter backwash samples indicates that swimmers frequently introduced fecal material into pools and thus might transmit pathogens to others through recreational water. RWI prevention will be optimized when swimmers minimize introduction of pathogens into the water by practicing good hygiene, aquatics staff maintain disinfectant level and pH according to state and local public health standards to inactivate pathogens, and state and local environmental health specialists enforce such standards.

human origin given that swimming is the most popular sport among children (6), over one third of the samples that tested positive for *E. coli* came from filters of indoor pools, and public outdoor pools are fenced in to limit access.

Swimmers have the power and responsibility to decrease the risk for RWIs by practicing good hygiene. In addition to minimizing the amount of fecal material introduced into recreational water, good swimmer hygiene, through bathroom breaks every 60 minutes and taking a pre-swim shower, minimizes the amount of urine and sweat introduced into the water (Box). Nitrogen in urine and sweat depletes free chlorine by combining with it to form di- and tri-chloramines, which are volatile respiratory and ocular irritants; free chlorine alone, at CDC-recommended concentrations, is not an ocular irritant. This study and others indicate that swimmers frequently introduce fecal material, microbes, urine (7), sweat, and other contaminants (8) into recreational water. Another study suggests that disinfectant level and pH frequently are not properly

maintained (9). Together, they all underscore the importance of a strong partnership among the swimming public, aquatics staff, and public health to prevent RWIs. RWI prevention will be optimized when swimmers minimize introduction of pathogens into the water by practicing good hygiene, aquatics staff maintain disinfectant level and pH according to state and local public health standards to inactivate pathogens, and state and local environmental health specialists enforce such standards. This critical partnership depends on maintaining robust state and local pool inspection programs (10) that provide leadership by enforcing public health standards and serving as a healthy swimming resource to aquatics staff and swimming public.

**Acknowledgment**

Joan Shields, CDC, who conducted the first U.S. study of the prevalence of *Cryptosporidium* spp. and *Giardia intestinalis* in swimming pools, and who died in December 2012.

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## Notes from the Field

### Transmission of HBV Among Assisted-Living-Facility Residents — Virginia, 2012

On June 29, 2012, the Rappahannock Area Health District in northwestern Virginia received a report of an acute hepatitis B virus (HBV) infection in an elderly resident of an assisted-living facility (ALF). The resident reported no risk factors for HBV infection except assisted monitoring of blood glucose (AMBG), which has been implicated in the transmission of HBV in ALFs and other long-term-care facilities (1,2). Rappahannock Area Health District investigated the source of the infection and the scope of transmission. Investigators observed facility infection control practices and procedures and conducted staff interviews. The facility was scheduled to close July 31, 2012, necessitating prompt response before residents were transferred.

ALF staff members routinely used pen-shaped lancing devices on multiple residents during AMBG, in contrast with long-standing recommendations and standards of care (3). The Virginia Department of Health (VDH) and CDC recommended testing current residents of the facility. Patient samples were tested for 1) human immunodeficiency virus, 2) hepatitis C virus (HCV) antibody with HCV RNA testing of all positives, 3) HBV DNA, 4) hepatitis B surface antigen, 5) total and immunoglobulin M antibody to hepatitis B core antigen, and 6) antibody to hepatitis B surface antigen. No transmission of human immunodeficiency virus or HCV was identified among the residents. Standard case definitions were used for acute and chronic infection, susceptibility to infection, and immunity (1).

Among current residents, 55 of 59 (93%) were tested, and 17 of 19 (89%) staff members were tested. Among the 55 residents tested, two acutely and two chronically HBV-infected patients were identified; all were aged >60 years and receiving AMBG, none shared rooms. One chronically infected patient transferred from another ALF after being diagnosed with acute HBV infection during an outbreak in January 2011 (1). At the time of the current outbreak, this patient had a high HBV viral load of  $6.3 \times 10^{10}$  IU/mL and appeared to be the source patient because the other chronically infected patient had a very low HBV DNA level. Testing was restricted to residents living at the facility since February 1, 2012, when the apparent source patient was admitted. The remaining three residents who received AMBG were susceptible to HBV infection.

All ALF residents were transferred to new facilities by August 10, 2012. Those facilities were notified by VDH about the outbreak, educated about proper AMBG and infection

control practices, and advised to consider patients with diabetes for hepatitis B vaccination based on CDC guidelines (4).

After similar outbreak investigations in Virginia (1,5), VDH has been using intense public health efforts to prevent outbreaks in other facilities. This work has included providing statewide education and training to ALF and nursing home staff members regarding safe AMBG (1,5), developing an infection control toolkit for facilities, and, most recently, partnering with the Virginia Department of Social Services to assess regulatory opportunities. Despite these efforts, HBV transmission occurred subsequently in another Virginia facility as a result of patient transfer. Training ALF and home health agency staff members on the proper methods for AMBG and increased oversight to measure adherence to safe diabetes-care practices remain critical public health priorities to prevent outbreaks of bloodborne pathogens in ALFs.

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## Announcements

### Hepatitis Awareness Month and National Hepatitis Testing Day — May 2013

In the United States, an estimated 3.5–5.3 million persons have chronic hepatitis B or chronic hepatitis C, and as many as three fourths of those with hepatitis C are unaware they are infected. To increase provider and public awareness of viral hepatitis and the need for testing, May has been designated Hepatitis Awareness Month, and May 19 is recognized as National Hepatitis Testing Day.

Testing of persons to assess current infection with hepatitis C virus, especially those born during 1945–1965 (i.e., “baby boomers”), who have a higher prevalence of chronic hepatitis C than other birth cohorts (1), is an important step in achieving the viral hepatitis prevention goals set forth by the U.S. Department of Health and Human Services (2). CDC also has published updated testing guidance for clinicians and laboratorians to ensure the identification of persons with current hepatitis C virus infection (3).

To promote viral hepatitis awareness beyond Hepatitis Awareness Month, CDC’s Division of Viral Hepatitis will partner with the National Hepatitis B United Coalition (Hep B United) to release a national, multilingual education campaign in June. This campaign will engage community partners to promote hepatitis B virus testing among Asian Americans and other populations experiencing health disparities related to hepatitis B.

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### Click It or Ticket Campaign — May 20–June 2, 2013

In 2011, approximately 21,000 passenger vehicle occupants (excluding motorcyclists) died in motor vehicle crashes in the United States, representing 66% of all motor vehicle crash deaths (1). An additional 2.6 million occupants were treated for injuries in emergency departments (2). Although seat belt use in the United States reached 87% overall, millions of persons continue to travel unrestrained (3). Using a seat belt is one of the most effective means of preventing serious injury or death in the event of a crash. Seat belts saved an estimated 11,949 lives in 2011. If everyone had been buckled up, an estimated 3,400 additional lives could have been saved (4).

Click It or Ticket, a national campaign coordinated annually by the National Highway Traffic Safety Administration to increase the proper use of seat belts, will be conducted May 20–June 2, 2013. Law enforcement agencies across the nation will conduct intensive, high-visibility enforcement of seat belt laws during both daytime and nighttime hours. Nighttime enforcement of seat belt laws is encouraged because seat belt use is lower at night (1). Campaign activities in 2013 focus on the need for all adults and all children who have outgrown booster seats\* to buckle up on every trip. Additional information about the 2013 Click It or Ticket campaign activities is available at <http://www.nhtsa.gov/PEAK>. Additional information on preventing motor-vehicle crash injuries is available at <http://www.cdc.gov/motorvehiclesafety>.

\* Guidelines for child passenger safety are available at [http://www.cdc.gov/motorvehiclesafety/child\\_passenger\\_safety/cps-factsheet.html](http://www.cdc.gov/motorvehiclesafety/child_passenger_safety/cps-factsheet.html).

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## Announcements

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### Recreational Water Illness and Injury Prevention Week — May 20–26, 2013

May 20–26, 2013, marks the ninth annual Recreational Water Illness and Injury Prevention Week. This observance highlights easy and effective steps swimmers can take to reduce health and safety risks at swimming pools, hot tubs/spas, and other recreational water venues.

Recreational water illness (RWI) can result from ingesting, inhaling aerosols of, or having contact with contaminated water from pools, hot tubs/spas, water play areas, interactive fountains, lakes, rivers, or oceans. These illnesses also can be caused by chemicals in the water or chemicals that volatilize from the water and cause indoor air quality problems.

With the incidence of RWI outbreaks increasing, swimmers need to practice good swimmer hygiene (e.g., taking a pre-swim shower and not swimming when ill with diarrhea) to help protect themselves and other swimmers from pathogens. Poor swimmer hygiene leads to microbial contamination of water in recreational water venues and thus can increase risk for RWI (1).<sup>\*</sup> Additional information on healthy swimming is available at <http://www.cdc.gov/healthyswimming>.

Public health agencies also have a role in preventing RWIs. In the United States, no federal agency regulates the design, construction, operation, and maintenance of public swimming pools and other public treated recreational water venues. All pool codes are independently written and enforced by state

and/or local agencies. In 2005, local, state, and federal public health officials and representatives of the aquatic sector identified the variation in pool codes as a barrier to RWI prevention. Since 2007, CDC and the New York State Department of Health have spearheaded development of the Model Aquatic Health Code (MAHC). The MAHC is a set of science-based and best-practice guidelines to reduce the risk for RWI, drowning, and pool chemical-associated health events. The first draft edition of the MAHC, which integrates 14 individual modules revised to address the first round of public comments, will be available for final public comment this summer. The first official edition of the MAHC is expected to be released by the 2014 summer swim season. Additional information on the MAHC is available at <http://www.cdc.gov/mahc>.

Injuries and drownings also can occur in and around recreational water. Drowning is the leading cause of injury death among children aged 1–4 years. On average, 10 persons die from drowning each day, including two aged <15 years (2). Additional information on water safety is available at <http://www.cdc.gov/homeandrecreationalsafety/water-safety/index.html>.

#### References

1. CDC. Microbes in filter backwash as evidence of the need for improved swimmer hygiene—Metro-Atlanta, Georgia, 2012. *MMWR* 2013; 62:385–8.
2. CDC. Drowning—United States, 2005–2009. *MMWR* 2012;61:344–7.

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<sup>\*</sup>Additional information at <http://www.cdc.gov/healthywater/swimming/protection/triple-a-healthy-swimming.html>.

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