CD Summary

July 24, 2007
Vol. 56, No. 15

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AN EPIDEMIOLOGY PUBLICATION OF THE PUBLIC HEALTH DIVISION
OREGON DEPARTMENT OF HUMAN SERVICES

ILLNESS ASSOCIATED WITH AQUATIC RECREATION

Water is an interesting compound: chemically, biologically, meteorologically, eschatologically, socially, historically, politically. The primordial soup whence—if you believe the theory—multicellular life first emerged was, of course, primarily water. Perhaps it is some primordial urge that pulls people back to water, or a symbolic effort to revisit the womb.* In any event, when we do go back, there are risks.

The greatest of these are not infectious. Shark bites are rare, but drowning is a recurring tragedy in Oregon; 72 drowning deaths occurred in 2005—most from recreational activities. But it is the risk from pathogenic microorganisms that animates this issue. Water is an effective medium for the dispersal of pathogens, with exposure routes including skin and mucous membrane contact (e.g., swimmer's itch, pseudomonal folliculitis, leptospirosis), inhalation (several respiratory viruses), and ingestion (almost any enteric pathogen). These pathogens include parasites, bacteria, and viruses shed by humans and other mammals, birds, snails, and other creatures—not to mention phytoplankton and other stuff that just lives in water.

INDICATIONS OF RISK

The association of water contact with disease has long been appreciated. In 1922 the "Committee on Bathing Places" of the American Public Health Association was surveying physicians about recreational water-associated problems.[1] There is early mention (without details) of typhoid outbreaks "unquestionably traced to bathing in polluted waters."[1, 2] Researchers have fairly consistently found that "swimmers" (i.e., those who went into the water) were more likely than non-swimmers to develop signs and symptoms of minor infections.[3-8]

This research was largely funded by regulatory agencies seeking to promulgate standards that could be applied to recreational waters, with concomitant implications for sewage and other wastewater treatment facility discharges. A variety of standards have been adopted with more or less scientific support† by different jurisdictions over the years. Early in the 20th century, coliform bacteria counts were pitched as an index of sewage contamination, and were used to assess the effects of various mitigation strategies. This made obvious sense. Coliform counts were high in sewage, and generally low in "clean" water; and swimming in sewage was obviously a Bad Thing. When total coliform counts were found to have little or no correlation with risk of disease, they were replaced as indicators, first by "fecal" coliforms and later by enterococci and *Escherichia coli*.[6]

Finding the perfect indicator has proven an elusive quest. Not all syndromes track well with the indicators proposed. Most non-diarrheal problems were ignored when choosing standards. Saltwater profiles differ from freshwater ones. Water temperature and other factors may limit the generalizability of study data. Viral levels don't correlate well with bacterial levels. "Best-fit" regression lines often obscure wild variation in observational data. And so on. It's complicated. The search for better indicators continues.[9]

The EPA used the data to develop standards for recreational water, but they are not binding. In practice, there is both de facto and de jure variation from these standards.[9] In Oregon, for example, selected ocean beaches are currently tested at weekly to monthly intervals for enterococcus levels. When levels spike above defined points, beaches are posted—i.e., warning signs go up. In addition, a handful of popular freshwater swimming areas are monitored by local agencies in Oregon, but this monitoring is anything but comprehensive: indicator levels can fluctuate considerably across short distances and time intervals,[8] but it is too expensive to collect the dozens of samples daily at popular sites, or to collect samples on weekends and holidays, when more people tend to swim. It takes about 24 hours to get test results, by which point conditions may have changed considerably. In summary, the utility of water sampling programs is difficult to confirm.

OUTBREAK-ASSOCIATED ILLNESS

Outbreak investigations provide a very different perspective on the risks of recreational water. Outbreaks have been traced to fountains[10] and wading pools[11]; swimming pools,[12] hot tubs, and wave pools[13]; freshwater lakes,[14, 15] rivers,[16] and ocean beaches—even backyard "kiddie pools."[17] More common pathogens in recent decades include *Shigella, Escherichia coli* O157:H7, *Cryptosporidium*, and noroviruses, but leptospires, hepatitis A, *Pseudomonas*, and the odd brain-dissolving protozoa‡ also pop up occasionally. Selected Oregon outbreaks are shown in the table *(verso)*.

One thing stands out from these investigations: notwithstanding all the historical concerns about sewage contamination, agricultural runoff, and the like, the source of virtually all of recognized outbreaks has been other bathers. As Pogo once said, "we have met the enemy and he is us." If someone poops in the water, a cloud of microorganisms disperses in four dimensions. If that cloud happens to

* perhaps not

† Typically the latter

‡ http://www.oregon.gov/DHs/ph/beaches/about_us.shtml

The **CD Summary** (ISSN 0744-7035) is published biweekly, free of charge, by the Oregon Dept. of Human Services, Office of Communicable Disease and Epidemiology, 800 NE Oregon St., Portland, OR 97232 Periodicals postage paid at Portland, Oregon.
Postmaster—send address changes to:
CD Summary, 800 NE Oregon St., Suite 730, Portland, OR 97232

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include pathogens, and other mouths are open wide enough, close enough, and soon enough, then people will be at risk. And even when people don't "actively" poop, fecal organisms on the skin wash off to some degree (albeit in much smaller average quantities) and add to the soup.

In pools, proper filtration and disinfection sharply reduce the dimensions of that cloud for most pathogens of concern, although some bugs—notably *Cryptosporidium*—are quite resistant to chlorine. Safety is compromised when pool maintenance is poor, and of course in natural bodies of water one can only wait for dispersal and die-off. In some lake settings, transmission can persist for days or weeks.[14, 15, 18]

Dilution factors can be very large, and the most "successful" waterborne pathogens (e.g., *E. coli* O157, *Shigella, Cryptosporidium*) tend to have relatively small infectious doses. A number of exacerbating risk factors have been identified, including stagnant water, bather crowding, lack of adequate toilet facilities, and the presence of very young bathers.[14] Among cases, a history of swallowing water or head immersion is typical.

PARTING SHOTS

Ameliorating the risk of recreational water-associated infections is a daunting challenge. Swimming is not an inherently Bad Thing to do. Risks must be kept in perspective. The risk (for enteric disease at least) is primarily dependent on recent bather density and on one's own propensity to swallow water—neither factor readily amenable to regulatory influence. Don't count on bimonthly enterococcus readings to prevent many of these illnesses.

Let us close with this benediction: get specimens for diagnosis whenever feasible; report suspected outbreaks promptly so that public health authorities can get everybody out of the pool; and keep your mouth shut when you're in the water.

Selected Oregon "Swimming" Outbreaks

Year	*Setting (County)*	*Bug*	*Cases**
1969	Wading pool, Jackson	*Shigella sonnei*	???
1991	Blue Lake, Multnomah	*S. sonnei*, *E. coli* O157:H7	>>59
1992	Water park, Lane	*Cryptosporidium*	>>17
1996	Loon Lake, Douglas	Norovirus-like	>32
1998	Municipal pool, Multnomah	*Cryptosporidium*	69
2003	Park fountain, Marion	*S sonnei*	111
2004	Blue Lake, Multnomah	Norovirus	>>33

** "Official" case counts may differ from reality by an order of magnitude or more. depending on study design, etc.*

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