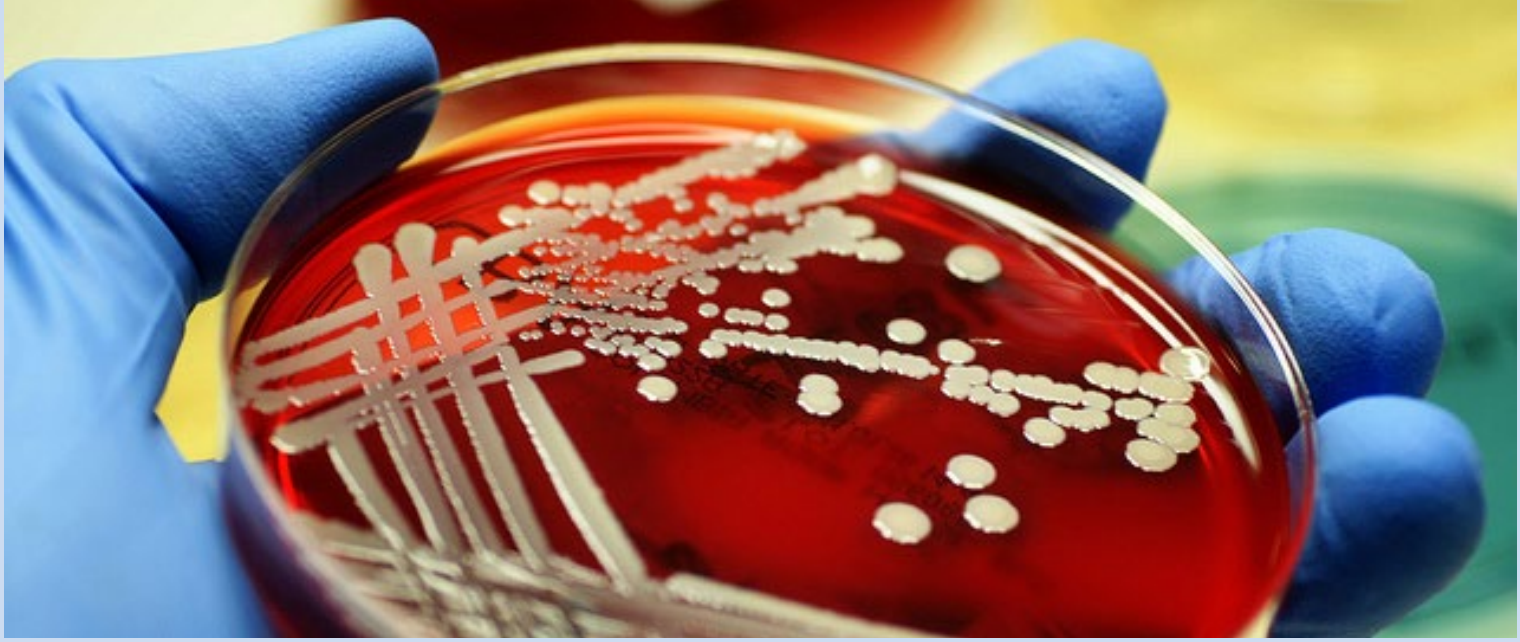

One Bad Bug

The Potential for Waterborne Spread of MRSA

By Kelly A. Reynolds, MSPH, PhD , Associate Professor at the University of Arizona College of Public Health

The emergence and increased prevalence of the 'superbug' bacterium known as MRSA (methicillin-resistant Staphylococcus aureus), has raised questions as to the routes of transmission related to disease. Reports of MRSA infections in the general population and evidence of the bacteria surviving in wastewater, tap water and drinking water biofilms creates alarm in the public and warrants a discussion of whether or not MRSA infections occur from tap-water exposures.

The Common Staph Bacterium

Staphylococcus aureus pathogens are isolated from humans more often than any other bacteria. Many people carry the organism on their skin or inside their nasal passages without effect. Kluytmans et al., (1997) estimate that 20 percent of people are persistent carriers of Staph while 60 percent are intermittent carriers. Another 20 percent are thought to rarely harbor the bacterium. Asymptomatic MRSA carrier rates in the nasal passage are much lower, at less than three percent, but can be as high as 9.2 percent. How these carrier ratios relate to health or disease transmission is unknown; however, carriers have been shown to be at increased risk of infection. The organism can also be found on domestic animals, livestock and inanimate environmental objects. For some, the bacteria are an opportunistic pathogen waiting for the right conditions to infect wounds that can result in skin and soft-tissue infections. Staph bacteria are a significant health problem in hospitals, where secondary infections can be acquired during the course of common procedures, such as urinary-tract infections following catheterization. Exposure to contaminated surfaces and air can also lead to more serious hospital-acquired infections, such as pneumonia and bacteremias.

Superbug Backgrounder

One type of Staph bacterium, known as MRSA, is resistant to commonly used antibiotics called beta-lactamases. First documented in a hospital in 1968, hospital-acquired (HA-) MRSA was a feared 'superbug' that was difficult to treat and appeared to be rapidly increasing in healthcare settings. By 1974, two percent of all Staph infections were the resistant MRSA. Today, MRSA is endemic in healthcare settings, where more than 64 percent of Staph infections are caused by MRSA. By the mid-1990s, MRSA infections were being identified in healthy persons (community-acquired or CA-MRSA) who had no previous contact with hospitals or other healthcare sites. At-risk groups were being identified from populations presumed to be some of the healthiest, such as firefighters, athletes and military personnel. By 2005, MRSA was identified as a national health crisis. During this year, nearly 368,000 hospital admissions were due to MRSA, with approximately 19,000 deaths each year in the US, representing a 500-percent increase in infections from 2003. If infected, the probability of dying from a MRSA infection is five percent. The mortality rate is dramatically higher for seniors, approaching 73 percent.

Differences in HA- and CA-MRSA were soon identified based on genetic characteristics. Essentially, hospital strains tend to cause milder infections with increased resistance factors to treatment while community strains are more susceptible to treatment but generally cause more aggressive infections due to the ability to produce a necrosis toxin.

Waterborne MRSA Routes

How community members primarily come into contact with MRSA is unknown. Risk factors for colonization in children include pet ownership, participation in sports and fingernail biting. Others have found that risks of MRSA infection are highest among people living in regions with high concentrations of livestock (i.e., cattle and pigs).

The potential for MRSA to be spread via aquatic environments is continually evaluated. An understanding of where MRSA persists in water, how well it survives and the effectiveness of current

Bad Bug, *continued on page 6* ▶

treatments are important considerations. If MRSA is present in tap water, can the bacteria be transmitted to humans via bathing or, worse yet, during the rinsing of wounds? Plano et al., (2011) concluded that bathers are an important source of Staph and MRSA contamination where the average person sheds a million Staph bacteria during the first 15 minutes of water immersion. According to the Centers for Disease Control and Prevention (CDC), there have been no reports of MRSA being spread through recreational water but the agency recognizes the potential risk of an infected person contaminating surfaces at recreational water facilities. While persons could theoretically become colonized from exposure to contaminated water, spread in properly maintained water systems, pools and hot tubs, it is considered unlikely due to the use of disinfectants (primarily chlorine) which effectively inactivates MRSA. However, MRSA has been isolated from various untreated and improperly treated aquatic environments where it can survive from days to weeks.

Risks of Untreated Water

Contact with seawater has been associated with an increased risk of Staph infections. Temperature is thought to play a role in the survival of MRSA in marine environments where higher concentrations are found in cooler climates. In a controlled laboratory study simulating recreational water conditions, both temperature and salinity had an effect on MRSA. The bacteria died off 28-percent faster at 20°C (68°F) compared to 13°C (55.4°F) and up to 44-percent faster in fresh water than in marine waters. MRSA has been isolated from 83 percent (10/12) of raw sewage samples in the US—a potential concern for wastewater reuse applications—but was rarely found in treated wastewater (eight percent; 1/12). Only one treatment plant harbored MRSA in treated wastewater but this was reportedly due to the irregular use of chlorine disinfectants. While it is not surprising to find MRSA in wastewater (given that the organism is shed in human feces and from the skin while bathing) the researchers suggest that MRSA could be cycling between the environment and humans, further stressing the need for complete disinfectant (i.e., tertiary) treatment of wastewater sources. Use of greywater in households, for agricultural and landscape irrigation and other applications may be contributing factors of MRSA infections in the community. Wound irrigation with tap water is a common practice. While tap water is not sterile, low concentrations of potentially pathogenic bacteria is not thought to initiate wound infections. Few studies have monitored the prevalence of MRSA in tap water. One researcher, however, monitored drinking water distribution network biofilms in a single municipal area and found beta lactamase-encoding resistance genes but did not find specific resistance genes found in MRSA.

> "Today, MRSA is endemic in healthcare settings, where more than 64 percent of Staph infections are caused by MRSA."

Prevention

MRSA infections typically manifest as small, red pimples-resembling a mosquito bite that is unusually painful with a blistery top. These pimples are often mistaken for a spider bite. The infection may form pus and can also present with a fever. Direct contact with a person or contaminated items is thought to be the primary transmission route. Thus, sharing personal items, such as towels or razors, is discouraged. MRSA enters the body through a break in the skin barrier. Thus, protecting cuts and scrapes from contact with potentially contaminated surfaces or persons is encouraged. The old adage of allowing a wound to breathe is combated by the need to protect the wound from outside pathogens. In terms of tap or recreational water risks, there simply is not any evidence that these environments spread MRSA infection.

References

1. Kluytmans, J.A.; Van Belkum and Verbrugh, H. "Nasal carriage of Staphylococcus aureus: epidemiology, underlying mechanisms, and associated risks." Clinical Microbiology Reviews, vol. 10, pp. 505-520, 1997.
2. David, M.Z. and Daum, R.S. "Community-associated methicillinresistant Staphylococcus aureus: epidemiology and clinical consequences of an emerging epidemic." Clinical Microbiology Reviews, vol. 23, pp. 616-687, 2010.
3. Plano, L.R.W.; Garza, A.C.; Shibata, T.; Elmir, S.M.; Kish, J. et al., "Shedding of Staphylococcus aureus and methicillin-resistant Staphylococcus aureus from adult and pediatric bathers in marine waters." BMC Microbiology, vol. 11, pp. 5-14, 2011.
4. Levin-Edens, E.N.; Bonilla, J.S.; Meschke and Roberts, M.C. "Survival of environmental and clinical strains of methicillin-resistant Staphylococcus aureus (MRSA) in marine and fresh waters." Water Research, vol. 45, pp. 5681-5686, 2011.
5. Goldstein R.E.; Micallef, S.A.; Gibbs, S.G. et al., "Methicillin-resistant Staphylococcus aureus (MRSA) detected at four U.S. wastewater treatment plants." Environmental Health Perspectives, vol. 120, pp. 1551-1558, 2012.
6. Li, T.S.; Choong, M.Y.; Wu, S.F. and Chen, K.F. "Irrigating methicillin-resistant Staphylococcus aureus-colonized and -infected chronic wounds with tap water." International Wound Journal, vol. March, pp. 1-2, 2012.