Archives of Environmental & Occupational Health, Vol. 64, No. 3, 2009

Response to Editorial on "Risk of Recreational Water Use in Southern California"

Mitchell V. Brinks, MD, MPH; Ryan H. Dwight, PhD; Jan C. Semenza, PhD, MPH

We are responding to the commentary regarding our investigation of the health risk of recreational water contamination in Southern California published in the fall 2008 issue of this journal.[1,2] The commentator dismisses the findings of our large-scale study with two unsubstantiated theories that lack scientific creditability and echo claims made by sewage industry representatives and their associated researchers. These theories were directly addressed in the original manuscript; however we will provide greater detail in this response.

First, the commentary suggests that US EPA and California water quality criteria are not relevant to Southern California "because ocean outfalls do not impact the shoreline with any frequency or regularity." Decades of research directly refute this claim. Southern California's coastline is dotted with offshore sewage outfalls (Figure 1). The regions' 20 million residents generate an enormous waste stream that results in 1.4 billion gallons of treated wastewater being discharged into the coastal waters every day. The region contains some of the largest treatment facilities in the country and their discharges can produce pollution plumes miles long, affecting local beaches. Beaches closest to outfalls (Huntington, Santa Monica, Doheney) consistently have elevated bacteria levels compared to beaches removed from these point sources (Crystal Cove, Zuma, Blacks). Sewage discharge plumes have been tracked and studied—a striking example presented by the University of California is an animated model of the Orange County waste plume shown to waft, wane and blow back onto Huntington Beach, which incidentally is the most highly attended beach in all of California. (http://www.sccoos.org/data/tracking/OCSD/.)

In addition, large volumes of tertiary treated sewage (>200 m/g/d) are discharged daily into rivers that drain onto recreational beaches. The two largest rivers in the region (*Los Angeles River* and *San Gabriel River*) have no natural perennial source of flow; 80% of the river water is treated sewage and the rest is comprised of untreated urban runoff and other permitted discharges.

The editorial argues that complete "disinfection" of sewage is achieved by current treatment regimens, eliminating any health risk from these discharges. While this laudable goal is certainly shared by all interested parties, it unfortunately remains unrealized. Millions of gallons of sewage are discharged each day into Southern California's coastal waters at substandard treatment levels according to federal criteria (receiving only primary treatment). Sanitation officials have represented chlorination as an excellent disinfection tool, which several treatment facilities employ. However, the lead scientist and primary author of US federal water quality guidelines and others reported that chlorination is very effective at killing the indicator bacteria but not the pathogenic viruses, thus masking the public health risk.[3,4]

However, the primary source of coastal water contamination in Southern California is from untreated runoff waters discharged onto recreational beaches. The region is one of the most highly urbanized and densely populated areas of the county, and consequently, large quantities of pollution are generated daily. The sources of contamination found in urban runoff are many and varied, including aging sewage infrastructure, illegal discharges, spills, and permitted discharges. Ironically, the author of the commentary in question can be viewed discussing a long list of sources of sewage contamination found in urban runoff. (http://video.google.com/videoplay?docid=-2210882608482859627).

Several investigations of urban runoff in Southern California have confirmed: the presence of human pathogens

Mitchell V. Brinks *is with Oregon State University*. **Ryan H. Dwight** *is the director of the Coastal Water Research Group*. **Jan C. Semenza** *is with the European Center for Disease Control*.

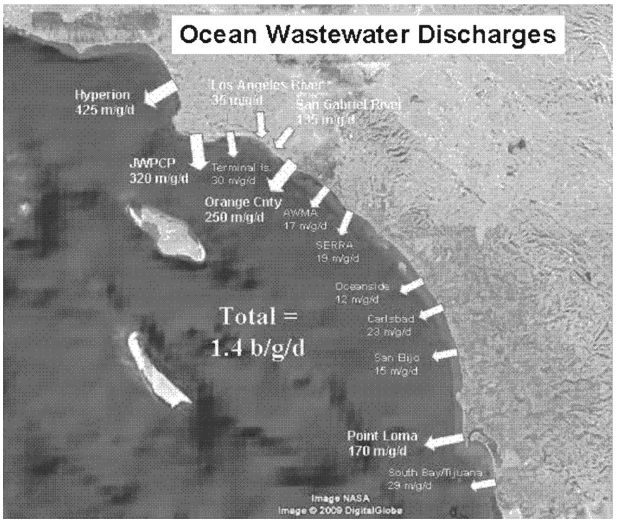

Fig. 1. Sewage Discharges into Southern California's Coastal Waters.

in urban runoff;[5–8] that urban runoff contaminates recreational coastal waters;[9–14] and that exposure to contaminated coastal waters in this region is associated with illnesses in swimmers.[15–18]

The second erroneous accusation states that our investigation assumes "all of the measured bacterial densities of enterococci or fecal streptococci originate from human sources." The commentary's theory rests on an assumption that indicator bacteria originate in the natural environment, and thus Southern California represents a unique setting where *enterococci* found in beach waters do not correlate with health risk. The validity of *enterococci* as an indicator of risk in recreational marine waters has been recognized by a worldwide body of epidemiologic research, four meta-analyses,[19–22] and by scientists at the US EPA, the European Union, and the World Health Organization.[23,24,25] More directly, three epidemiology studies have been conducted at open ocean beaches in Southern California and they all report *enterococci* concentrations in the water were a statistically significant predictor of health risk in swimmers.[15,26]

We disagree with the commentator and researchers who claim the high levels of *enterococci* found in Southern California's coastal waters originate from non-human sources. Alleged environmental sources of indicator bacteria (which are not indigenous to the marine environment) include: (1) Sand and soil; however, beach sand is clean where the water is clean; and the vast majority of sand beaches have low levels of waterborne bacteria. Polluted waters contaminate the sand, not visa versa. (2) Wildlife that are concentrated in wetlands and their presence, even in high densities, does not correlate with contamination of open ocean beaches (wetlands degrade biological pollutants—the water draining out is cleaner than the inputs). (3) Kelp—These photosynthetic brown algae have no association with enteric bacteria, and ironically, they are considered an indicator species of clean water. These theories divert attention from the massive volumes of human waste discharged daily and blames the natural environment for the contamination.

There is no epidemiologic evidence for any of these theories and thus no scientifically appropriate rationale for adjusting federal and international health risk models used in our analysis. In fact, all previous epidemiology studies have been conducted in the natural environment, so any confounding variance potentially contributed by non-human sources would have been accounted for in their models.

The commentary also extrapolates to open ocean beaches the findings of a single epidemiological investigation[18] conducted at a highly modified embayment and based on those results then disregards the scientific relationship underlying US and California water quality criteria. This exact type of inference was explicitly warned against by both the investigators of the study, as well as by the journal editors.[27] We defer to the site-specific qualifications best articulated in those articles in regards to the inapplicability of the results to open ocean beaches.

Our analysis is founded on the most comprehensive sets of coastal water quality and human exposure data that have been presented in the scientific literature. The analysis used the two recognized equations that are the basis for Federal and international water quality criteria. The equations were applied to data for every beach in Southern California over 5 years to model health risk estimates generated over time.

Two important findings of our investigation remain uncontested. The first observation is beach attendance is the strongest determinant in the magnitude of the public health burden, not water quality. The second observation is that current recreational water quality criteria (that define 1.9% gastrointestinal illness rate as acceptable) results in a significant disease burden for the 56 million Southern California beach swimmers. It is our sincere interest that the scientific discourse moves beyond attributing coastal water contamination problems to the environment, and focuses on developing a solution to the large burden of illness from the pollution.

****

For comments and further information, address correspondence to Ryan H. Dwight, Coastal Water Research Group, 22042 Catalina Circle, Huntington Beach, CA 92646, USA.
E-mail: ryanhdwight@yahoo.com

****

References

1. Brinks MV, Dwight RH, Osgood ND, et al. Health risk of bathing in Southern California coastal waters. *Arch Environ Occup Health*. 2008;63:123–35.
2. Clifton C. Editorial for health risk of bathing in Southern California coastal waters by Brinks et al. *Arch Environ Occup Health*. 2008;63:136.
3. Cabelli VJ. Swimming-associated illness and recreational water quality criteria. *Wat Sci Technol.* 1989;21:13–21.
4. Tree JA, Adams MR, Lees DN. Chlorination of indicator bacteria and viruses in primary sewage effluent. *Appl Environ Microbiol*. 2003;69:2038–2043.

5. Gold M, Bartlett M, Dorsey J, McGee C. *Storm Drains as a Source of Surf Zone Bacterial Indicators and Human Enteric Viruses to Santa Monica Bay*. Santa Monica, Calif: Santa Monica Bay Restoration Project; 1991.
6. Field R, O'Shea M, Brown MP. The detection and disinfection of pathogens in storm-generated flows. *Water Sci Technol.* 1993;28:311–315.
7. Bay SM, Greenstein DJ. Toxicity of dry weather flow from the Santa Monica Bay watershed. *Southern California Academy of Sciences*. 1996;95:33–45.
8. Jiang, S. C., R. Nobel, W. Chu. Human adenoviruses and coliphage in urban runoff-impacted coastal waters of southern California. *Appl Environ Microbiol*. 2001;67:179–184.
9. Dwight RH, Semenza JC, Baker DB, Olson BH. Association of urban runoff with coastal water quality in Orange County, California. *Water Environ Res.* 2002;74:82–90.
10. Noble RT, Dorsey JH, Leecaster M, et al. A regional survey of the microbiological water quality along the shoreline of the Southern California Bight. *Environ Monit Assess.* 2000;64:435–447.
11. Ackerman D, Weisberg SB. Relationship between rainfall and beach bacterial concentrations on Santa Monica bay beaches. *J Water Health*. 2003;1:85–89.
12. Schiff KC, Morton J, Weisberg SB. Retrospective evaluation of shoreline water quality along Santa Monica Bay beaches. *Mar Environ Res*. 2003;56:245–53.
13. Washburn L, McClure KA, Jones BH, Bay SM. Spatial scales and evolution of storm water plumes in Santa Monica Bay. *Mar Environ Res*. 2003;56:103–125.
14. Digiacomo PM, Washburn L, Holt B, Jones BH. Coastal pollution hazards in Southern California observed by SAR imagery: storm water plumes, wastewater plumes, and natural hydrocarbon seeps. *Mar Pollut Bull.* 2004;49:1013–1024.
15. Haile RW, Witte JS, Gold M, et al. The health effects of swimming in ocean water contaminated by storm drain runoff. *Epidemiology*. 1999;10:355–363.
16. Gaffield SJ, Goo RL, Richards LA, Jackson RJ. Public health effects of inadequately managed stormwater runoff. *Am J Public Health*. 2003;93:1527–1533.
17. Dwight RH, Baker DB, Semenza JC, Olson BH. Health effects associated with recreational water use in urban vs. rural California. *Am J Public Health*. 2004;94:565–567.
18. Colford Jr. JM, Wade TJ, Schiff KC, et al. Water quality indicators and the risk of illness at beaches with nonpoint sources of fecal contamination. *Epidemiology*. 2007;18:27–35.
19. Saliba LJ, Helmer R. Health risks associated with pollution of coastal bathing waters. *World Health Stat Q*. 1990;43:177–184.
20. Prüss A. Review of epidemiological studies on health effects from exposure to recreational water. *Intl J Epidemiol.* 1998;27:1–9.
21. Zmirou D, Pena L, Ledrans M, Letertre A. Risks associated with the microbiological quality of bodies of fresh and marine water used for recreational purposes: summary estimates based on published epidemiological studies. *Arch Environ Occup Health*. 2003;58:703–711.
22. Wade TJ, Nitika P, Eisenberg JN, Colford JM. Do US EPA water quality guidelines for recreational waters prevent gastrointestinal illness? A systematic review and meta-analysis. *Environ Health Perspect*. 2003;111:1102–1109.
23. USEPA. Ambient Water Quality Criteria for Bacteria-1986. *EPA*; 44015–84-002. Washington, DC. Office of Water Regulations and Standards Division, United States Environmental Protection Agency. 1986.
24. European Union/Council of European Union (EP/CEU). Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006, Concerning the Management of Bathing Water Quality and Repealing Directive 76/160/EEC. *Official Journal of the European Union*. 2006;L64:31–51.
25. World Health Organization. *Guidelines for safe recreational water environments, coastal and fresh waters*. Vol 1. Geneva, Switzerland: World Health Organization; 2003.
26. Colford J, Schiff K, Arnold B, et al. Screening candidate water quality indicators for associations with swimming-related illness. Presentation at: US EPA National Beach Conference; April 22, 2009; Huntington Beach, CA.
27. Schwab KJ. Are existing bacterial indicators adequate for determining recreational water illness in waters impacted by nonpoint pollution? *Epidemiology*. 2007;18:21–22.