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Residential History and Groundwater Modeling

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In a case-control study, Gallagher et al. (2010) reported elevated breast cancer risk among women residing on Cape Cod, Massachusetts, who consumed water from wells classified as impacted by wastewater treatment plant effluent from the Barnstable Water Pollution Control Facility (BWPCF). Exposure classification was based on a U.S. Geological Survey model of groundwater flow, historical public water supply data, and the women's residential histories. Recent detection of hormones and other wastewater-associated endocrine-disrupting compounds (EDCs) in drinking water supplies nationwide has raised concerns about health effects, so we applaud the authors for an inventive examination of this issue, which is difficult to study because historical exposure measurements are lacking.

However, drinking water data for Cape Cod suggest additional exposures that are relevant to this analysis. An alternative, or possibly additional, explanation for the elevated breast cancer risk may be drinking water exposures to volatile organic compounds (VOCs), some of which are mammary gland carcinogens (Rudel et al. 2007). Although the Barnstable Water Company (BWC)—which provided water to exposed participants—included three wells impacted by the BWPCF, it also included three wells contaminated by VOCs from a nearby airport. Treatment was installed in 1991 (Keijser H, personal communication), so for 25 of the 27 years of the study's exposure period (1966–1993), there was no treatment to remove VOCs. Contributions of these VOC-contaminated wells to the BWC system were similar to, and in some cases exceeded, the contributions from BWPCF-impacted wells. In 1975, the wells impacted by the airport (Maher wells 1, 2, and 3) supplied 43% of BWC water, compared with 41% from the wastewater-affected wells (Hyannisport, Simmons Pond, and Straightway) (LeBlanc et al. 1986); in 1986, the proportions were 33% and 37%, respectively (Bratton 1991). In addition, at least one BWPCF-impacted well also contained VOCs, as Gallagher et al. (2010) mentioned.

An unspecified number of BWPCF-exposed participants relied on private wells, which were probably not affected by the airport. However, from 1970 to 1990, only around 10% of homes near the BWPCF relied on private wells (Silent Spring Institute 1997), so most of the BWPCF exposures

occurred through the public supply that was impacted by airport-related VOCs.

A further complication is that Gallagher et al. (2010) stated that they “determined that the BWPCF was the only source of wastewater effluent with the potential to impact the drinking water of this study population”; however, we doubt that. Drinking water supplies of participants in both the exposed and nonexposed groups likely contained wastewater contaminants originating from septic systems. Among the exposed group, discharges from septic systems contributed substantially to the volume of water pumped from two of the BWPCF-impacted wells (Barlow 1994). Wells serving nonexposed participants also were impacted by septic systems. From 1972 to 1985, over half of the public wells in the entire study area contained elevated nitrate concentrations (Silent Spring Institute 2002). In addition, the largest source of groundwater nitrate on Cape Cod is wastewater from septic systems (Brody et al. 2006 and references cited therein).

Despite uncertainty about the composition of drinking water exposures, Gallagher et al. (2010) did provide evidence that drinking water in this area may have been associated with breast cancer. Their study highlights the value of routine tracking of drinking water quality and supports further epidemiologic breast cancer research on EDCs and VOCs in drinking water.

The authors declare they have no actual or potential competing financial interests.

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REFERENCES

- Barlow PM. 1994. Particle-Tracking Analysis of Contributing Areas of Public-Supply Wells in Simple and Complex Flow Systems, Cape Cod, Massachusetts. U.S. Geological Survey Water-Supply Paper 2434. Marlborough, MA:U.S. Geological Survey. Available: <http://pubs.usgs.gov/wsp/wsp2434/> [accessed 5 August 2010].
- Bratton L. 1991. Public Water-Supply in Massachusetts, 1986. Open-File Report 91-86. Boston, MA:U.S. Geological Survey.
- Brody JG, Aschengrau A, McKelvey W, Swartz CH, Kennedy T, Rudel RA. 2006. Breast cancer risk and drinking water contaminated by wastewater: a case control study. *Environ Health* 5:28; doi:10.1186/1476-069X-5-28 [6 October 2006].
- Gallagher LG, Webster TF, Aschengrau A, Vieira VM. 2010. Using residential history and groundwater modeling to examine drinking water exposure and breast cancer. *Environ Health Perspect* 118:749–755; doi:10.1289/ehp.0901547 [Online 17 February 2010].

- LeBlanc DR, Guswa JH, Frimpter MH, Londquist CJ. 1986. Ground-Water Resources of Cape Cod, Massachusetts. Hydrologic Investigations Atlas HA-692. Reston, VA:U.S. Geological Survey.
- Rudel RA, Attfield KR, Schifano J, Brody JG. 2007. Chemicals causing mammary gland tumors in animals signal new directions for epidemiology, chemicals testing, and risk assessment for breast cancer prevention. *Cancer* 109:2635–2666.
- Silent Spring Institute. 1997. Cape Cod Breast Cancer and Environment Study: Final Report, December 8, 1997. Newton, MA:Silent Spring Institute.
- Silent Spring Institute. 2002. Cape Cod Water Data. Available: <http://www.silentspring.org/our-research/health-and-environmental-mapping/cape-cod-water-data> [accessed 5 August 2010].

Residential History and Groundwater Modeling: Gallagher et al. Respond

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We thank Schaider et al. for their interest in our research on possible environmental causes of breast cancer in upper Cape Cod, Massachusetts (Gallagher et al. 2010). Our study was prompted by an earlier spatial analysis that revealed a geographic overlap between groundwater plumes in upper Cape Cod and an area of increased breast cancer risk. These plumes indicated areas of concern around landfills and wastewater facilities, large point sources of contaminants to groundwater, as shown in Figure 1 of our article (Gallagher et al. 2010). We determined that among these plumes, the plume associated with the Barnstable Wastewater Pollution Control Facility (BWPCF) was the only point source with the potential to impact the drinking water of our study population. The BWPCF treats both residential and commercial waste from a broad geographic area.

In our study (Gallagher et al. 2010), we applied an extensive groundwater model to evaluate historic conditions and determined that effluent from the BWPCF could have reached public drinking water wells as early as 1966. Taking into account residential histories and drinking water source (public, private, and bottled water) among cases and controls, we found an association between Barnstable Water Company (BWC) drinking water impacted by the BWPCF plume and breast cancer that increased with longer latency and greater exposure duration. As Schaider et al. point out, drinking water contamination by private septic systems is ubiquitous in this area. However, because this source of pollution likely affects cases and controls across the entire study area in a similar manner and because the results of a prior study on this topic did not find an association (Brody et al. 2006), this unmeasured source of pollution should not confound the results of our analysis. Nevertheless, we do acknowledge in our article that there may be residual confounding by other unmeasured sources of

environmental contamination, including the Barnstable Airport. We agree with Schaidler et al. that these exposures may also contribute to the risk of breast cancer, although the earliest data we are aware of show no appreciable levels of volatile halogenated compounds in 1984 BWC water samples (Janik 1987). With only limited historical data available, we cannot be sure of the exact timing and geographic distribution of these other exposures. However, a very tight correlation would be necessary for these confounders to account for the observed associations with the BWPCF plume, and other exposures would have to date back to 1966.

Fortunately, groundwater sources of drinking water in this area are subject to more protections today, and we agree that ongoing monitoring of known and emerging contaminants is important to maintain water quality.

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REFERENCES

- Brody JG, Aschengrau A, McKelvey W, Swartz CH, Kennedy T, Rudel RA 2006. Breast cancer risk and drinking water contaminated by wastewater: a case control study. *Environ Health* 5: 28.; doi: 10.1186/1476-069X-5-28; [6 October 2006].
- Gallagher LG, Webster TF, Aschengrau A, Vieira VM. 2010. Using Residential History and Groundwater Modeling to Examine Drinking Water Exposure and Breast Cancer. *Environ Health Perspect* 118:749–755; doi:10.1289/ehp.0901547 [Online 17 February 2010].
- Janik D. 1987. State of the Aquifer Report: Cape Cod Basin. Barnstable, MA: Cape Cod Planning and Economic Development Commission.

Importance of Particle Size-Fraction Analysis in Suspensions

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We would like to comment on the article by Cho et al. (2009), which was published in the November 2009 issue of *Environmental Health Perspectives (EHP)*. We read the paper with great interest because the size-dependent effects of particulate matter are very important but have not yet been definitively clarified. In reporting the size-dependent effects of particles, it is essential to know the size distributions of the applied

particle solutions, as well as the specific particle size fractions administered.

Cho et al. (2009) did not use direct inhalation exposure, which is the most relevant exposure route for airborne particles (Oberdörster et al. 2005). The particulate matter was sampled, resuspended in methanol and saline, and administered via pharyngeal aspiration to mice (50 µL saline containing 25 or 100 µg particulate matter). Because of the effort required for inhalation studies with size-fractionated airborne particulate matter, the particles were collected and resuspended. However, it is regrettable that the authors did not analyze the size fraction in the suspensions. Particles react in suspensions, especially by forming aggregates, and the reactions are dependent upon the specific composition of the suspension liquid (Teeguarden et al. 2007). Therefore, we consider it a significant drawback of the study of Cho et al. (2009) that they made statements concerning particulate size effects without taking into consideration the characteristics of the particle suspension used for aspiration. This should have been clearly addressed in the “Discussion” of their article. We are surprised that the reviewers did not highlight this point.

We are interested in studies that take into account the size effects of particles, both

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The paper makes an outstanding contribution to the knowledge of environmental epidemiology and was selected because of its quality, originality, importance and expected impact.

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