“Drinking Water and the Developing Brain” with Ellen Silbergeld

Transcript of Cerebrum Podcast

Guest: Ellen K. Silbergeld, holds a Ph.D. in environmental engineering from John Hopkins University, where she is a professor in epidemiology, environmental health sciences, and health policy and management. Her research and professional activities bridge science and public policy, with a focus on the incorporation of epidemiology and mechanistic toxicology into environmental and occupational health policy. Her areas of current focus include the health and environmental impacts of industrial food animal production; cardiovascular risks of arsenic, lead, and cadmium; and immunotoxicity of mercury compounds. She has served as a science advisor for the Environmental Protection Agency, Department of Energy, Centers for Disease Control, National Institute of Environmental Health Sciences, Occupational Safety and Health Administration, and international organizations, including the World Bank, United Nations Environment Programme, World Health Organization, Pan American Health Organization, Food and Agriculture Organization, and the International Labour Organization. She has served as editor-in-chief of *Environmental Research* and has published more than 450 peer-reviewed articles, monographs, and reviews. She is the recipient of a lifetime achievement award from the Society of Toxicology, the Barsky Award from the American Public Health Organization, and a MacArthur Foundation “genius” award.

Host: Bill Glovin serves as editor of *Cerebrum* and the *Cerebrum Anthology: Emerging Issues in Brain Science*. He is also executive editor of the Dana Press and *Brain in the News*. Prior to joining the Dana Foundation, Mr. Glovin was senior editor of *Rutgers Magazine* and editor of *Rutgers Focus*. He has served as managing editor of *New Jersey Success*, editor of *New Jersey Business* magazine, and as a staff writer at *The Record* newspaper in Hackensack, NJ. Mr. Glovin has won 20 writing awards from the Society of Professional Journalists of New Jersey and the Council for Advancement and Support of Education. He has a B.A. in Journalism from George Washington University.

Bill Glovin: Woody Allen once wrote a comedy called *Don't Drink the Water*. But, as we recently learned from what transpired in Flint, Michigan, there's nothing funny about our tap water. Hi, I'm Bill Glovin, editor of *Cerebrum*, the Dana Foundation's Neuroscience publication and welcome to our monthly podcast.

This month's guest is Ellen Silbergeld, author of our July feature, “Drinking Water and the Developing Brain.” Flint and its potential repercussions is what inspired my advisory board to recommend this topic of neurotoxicity in water. Flint fueled outrage and seemingly more testing and heightened awareness, but will it be sustained? Has anything changed since Flint? What are some of the issues that the mainstream media overlooks?

Dr. Silbergeld is a Professor of Epidemiology, Environmental Health Sciences and Health Policy and Management at John Hopkins, and one-time winner of the

MacArthur Foundation's Genius Grant. The grant was given for her work in identifying preventable causes of human disease related to environmental exposures. Her resume is too long to recite here, but some highlights include working as a science advisor for the EPA, Department of Energy, CDC, OSHA, and a variety of international organizations, including the World Bank, the UN, and the World Health Organization. She has served as Editor in Chief of *Environmental Research* and is the recipient of a Lifetime Achievement award from the Society of Toxicology. Welcome, Dr. Silbergeld. Let's begin with, how do you know if a child or adult suffers from lead poisoning?

Ellen Silbergeld: That's a very good question, and it actually relates the whole field of neurotoxicology and neuropsychiatric diseases, in that with rare exceptions, they generally manifest with general and often overlapping symptoms. Like inattentiveness, delayed reaction, problems in memory. To make a specific connection, we really have to fill in the other square in toxicology, which is what is the exposure? But certainly, it's now often the case. I know it certainly has been in Baltimore, where we've been studying lead for a long time, that when children are having general problems in learning or seem to hit a level of achievement that they can't transcend, often that's the time that provokes a lead test.

Bill Glovin: Are there acceptable levels?

Ellen Silbergeld: Well, I think that in a perfect world, we would like to see no level of lead in any child's blood. But as a practical matter, in terms of looking at delivering prevention to populations, CDC has decided that a blood level of five, that's five micrograms per deciliter of blood, which is very low, is the upper-bound of what can be acceptable.

Bill Glovin: You write that developmental neurotoxins or DNTs affect brain development from the pre-natal period to childhood. Why isn't the brain affected after that period?

Ellen Silbergeld: Well, it is. But I think then we start moving into a different kind of neurotoxicology and neurotoxicity. I was speaking really at the interaction of substances that have neurotoxic properties with the developmental stage of the brain. Now why do we focus on that specifically? It's really because of the complexity of all those early processes that are jammed into a relatively short period, starting early in gestation and lasting probably through mid-adolescence.

And that's when the brain really assembles itself, starting from embryonic stem cells all the way to a highly intricate wired multi-computer, as many people like to talk about the brain. And because of that period of plasticity and development, neurotoxic agents have very specific effects that are different from the same exposure that occur to the fully developed adult brain.

Bill Glovin: Did DNTs affect mental and physical capacity in any other ways in teenagers or adults?

Ellen Silbergeld: Well, certainly. Usually higher levels of lead are known to affect the brain in adults and in adolescents. In fact, just at the time when we were starting to make a very fateful decision in terms of public health, and that was to use tetraethyl lead in gasoline. There were stories, actually one was published in The *New York Times* in the early-1920s referring to neuropsychiatric symptoms within the workers at the DuPont plant in Delaware that was making tetraethyl lead. And it was known as the House of the Butterflies, because the workers had this sensation, disturbed sensorium, of insects crawling all over their faces.

And we certainly know that at high levels of lead, in adults as well as in children, you can have convulsions, and in fact death. But they are very specific processes that are described in the paper for specific neurotoxic agents, depending on the time at which the exposure occurred. And we can really discern those differences, which are the interaction between the exposure and the timing of brain development.

Bill Glovin: Israel bans fluoride in drinking water, claiming that it leads to a host of conditions, including cognitive impairment. And Eric Brockovich fought against it. What is your view?

Ellen Silbergeld: Well, I think that we're really at a point where we do have to reassess this, in that the original goal of fluoridation was, of course, to prevent dental cavities and to produce healthy teeth, particularly in young children. But that was a time in which there were no real other sources of fluoride exposure. And in fact, the evidence clearly indicates the fluoridation of water during that period of time really had a benefit on dental health.

But now we have lots of sources of fluoride in the diet, and a whole range of different inputs of fluoride in our diet, apart from drinking water, and I think it's probably time we reevaluated what level of fluoride do we want to attain, and do we want to rethink the mass fluoridation of water? I'm not aware that there's been much evidence looking at fluoridation and neurotoxicity, but there certainly have been concerns for other toxicities.

Bill Glovin: You write that many Endocrine Disrupting Chemicals, or EDCs, have been detected in watersheds in the US, and not only there, but the blood of almost all Americans, and that one in particular, Bisphenol A, leaches into drinking water and other beverages from containers, including baby bottles. Is this characteristic of all baby bottles or just some, and can consumers detect their presence from labeling?

Ellen Silbergeld: Bisphenol A is a compound that's added to plastic to make it soft and flexible. It's not easy for a consumer to detect that just by looking at plastic. Many plastics are now labeled as BPA-free, and there's been a long debate with the

Food and Drug Administration about banning the use of BPA in baby bottles, but it hasn't happened yet in the United States.

Bisphenol A is, of course, only one of a whole host of compounds that have actions on a range of endocrine systems, and they become of course, of concern for developmental neurotoxicity, because of the role of hormones. From thyroids, from antigens, estrogens, in the development of the brain.

Bill Glovin: DNTs have been linked to autism through environmental interactions that include polymorphisms in genes and epigenetic modifications of gene expression. Can you explain what that means in sort of simple language?

Ellen Silbergeld: Sure. I think the real breakthrough in research on autism, as with many complex diseases, was the realization that very few of them are purely genetic in origin. While there are probably more diseases that can be described just to an environmental exposure, like lead, the vast majority of diseases come about for an interaction between genes and exogenous exposures. That has been an important realization, particularly for autism. The epidemiology of autism had never really supported classic mendelevium inheritance, if you will. So there always was a sense that while there seemed to be a pattern of autism within families, it didn't follow any clear genetic patterning.

And of course, families share environments as well as genes, so that then changed the whole focus of research to try and study both external exposures, including endocrine disruptors and other compounds, as well as genetic polymorphisms, which might be seen more as susceptibility factors. If one plus one equals two, one by itself does not equal a disease, but put together, you have a combination of increased susceptibility and the agent that can act, that can cause problems.

Now the issue of epigenetics is, again, one of these breakthroughs in understanding exactly how genes function to control, react, and produce the physiologic and biochemical events of our body. And that is, we used to believe that everything that was genetic followed classic, what we call mendelevium inheritance, that there would be a change in the gene, but we would look at was et cetera, et cetera. We've come to realize that there's more to just the gene. Another key event in whether or not a gene is associated, say with the color of your eyes, or the color of the coat in mice. Had to do with whether or not the gene was actually turned on or off.

So, the gene could be in your genome, kind of like a book on the shelf, but unless the book is taken off the shelf, opened up, and a copy made, that would be transcription, and then turned into a protein, it doesn't really matter what's happened to that gene. It turns out, there's a whole other system related to the gene, which is called Epi, or around the gene, Epigenetics, and that is a whole range of molecules that actually control the expression of the gene. Is it going to

turn into ... That is, is it going to be available for transcription, and then can a protein be made from it?

Bill Glovin: Quite interesting. I was Googling things, and to prepare for this, and I came across a 2009 *New York Times* article that began with these words, and I quote. "The 35-year-old federal law regulating tap water is so out of date, that the water Americans drink can pose what scientists say are serious health risks and still be legal. Only 91 contaminants are regulated by the Safe Drinking Water Act. Yet, more than 60,000 chemicals are used within the United States, according to the Environmental Protection Agency estimates." It goes onto say, "That not one chemical has been added to the list of those regulated by the Safe Drinking Water Act since 2000." Why is this?

Ellen Silbergeld: Well, the Safe Drinking Water Act is really a tragedy. It was one of the first environmental statutes passed, and I guess we can excuse some of the gaping holes in that law, because we were still trying to figure out how environmental laws should be written, how they should be implemented, and how should they be enforced. So, I look upon it as really a kind of very early beta test of environmental laws. It's not just that it hasn't regulated any other compounds. The way in which the Safe Drinking Water Act now requires testing for water, even of the things they have regulated, and we found this out through the tragedy unfolding in Flint, Michigan.

Basically, there's no prescribed schedule by which water companies have to test water, even for the things they're supposed to test them for. Many of them even test the water at places that have nothing to do with where people drink. Now when you're drinking, you're usually in your house, or you're at work, you're at a water fountain, or you're at the tap. You turn on the tap you get some water. That's where you want to know, is your water safe, right?

No. Most water companies actually test the water back at the water treatment plant, before it's gone through the whole system. Long before it's gotten to you. It would be kind of like doing food safety by testing chickens on the farm, rather than chicken meat that you buy in the store. So there's a tremendous amount wrong with that law.

Bill Glovin: All right, so obviously our aging infrastructure affects things. Is it even possible-

Ellen Silbergeld: Well, it's particularly worse, of course, for lead, because we like most countries have, as you say, not just an aging infrastructure, but an old one. And that includes the use of lead and lead solder in drinking water systems. Now those systems are working quite well. In fact, I was once on-site in Marce, France, where they dug up a water pipe under the street to replace it, and it happened to have been laid by Julius Caesar. So, it doesn't decay, but unfortunately, it can release lead, literally for millennia.

Bill Glovin: Wow. So is it even plausible to think that we could sort of renovate the infrastructure that's so old. I mean it would be probably incredibly expensive.

Ellen Silbergeld: Well, we could take a kind of prioritization the approach. That would require us, of course, to actually measure lead in water so we figure out where the big problems are, and we can deal with worst problems first. There were also some water treatments that we can do to prevent the release of lead into water. That was one of the other great tragedies of lead. They switched their water supply and forgot to do anything about the water, even though it was different from what had been there before.

And then we can slowly, but surely start to replace. We make very great strides in this country in terms of lead-based paint in housing. And back when that was the hot button issue, when I was first starting to work on lead, at Johns Hopkins, if you told me that we would have gotten that many houses free of lead paint, I could never have believed it. But, you know, we did. So, we need to start doing this.

Bill Glovin: Has Flint actually led to more awareness? For example, my wife's a teacher in the public-school system in Newark, and suddenly they're testing the water at the school, the elementary school, and throughout the school system, and finding that there's problems, which probably never would have happened if Flint didn't transpire and make national headlines. So, have you seen any marketed improvement since that event?

Ellen Silbergeld: Well, I've seen improvement in the sense that many cities have done focus testing, and many of them quite rightly on schools, which had been amazingly exempt from testing under the Safe Drinking Water Act, which is pretty amazing. So that's good, but this is kind of a helter-skelter response. It doesn't embody any kind of concerted, organized system, or really any guarantee that after this particular event fades from the public mind, that we won't go back to the same problem.

Bill Glovin: Wow. That's tragic. Are there sources where a listener can find out where to get information on their own drinking water and what it may contain, at least as far as the inorganic DNTs?

Ellen Silbergeld: Well, it would be very interesting for readers to try and do that. One of my former students who lives up in Newton, Massachusetts, was inspired by the Flint story to ask her water supplier to find out whether they had tested the water for lead. Well, it turned out that the last time they tested it was nine years ago, and they tested it at the water treatment plant, so in fact, there was no information available for her as to what the quality of her water that she was drinking in her house. What I think would be excellent is that all Americans went and asked for this information.

Bill Glovin: Your article concludes with the contention that, and I quote, "Knowledge of toxic chemicals in our air is much further along than in our drinking water," unquote. Clearly, we are lagging behind in this vital area. Is it corporate interest, ineffective government, or both? What needs to change?

Ellen Silbergeld: Well, as I said, I think a lot of it was the fact the Safe Drinking Water Act is a very early environmental statute. When the Clean Air Act came along, we had lots of things built into that act. For example, with the Clear Air Act, if you look out your window right now, and you see a smudge of black smoke coming out of a stack, you can actually call your state environmental agency.

If they don't help you, you call the regional office of the EPA and you say, "I think I've seen some air pollution here. Would you come?" You have a right to do that and they have to respond to you. They also, for air, have monitoring all over the country, which is continuously monitoring air quality. And you can get that data straight off the EPA website. In addition, if you are concerned about a particular chemical in the air and there is no standard, a citizen can petition the EPA to set a standard.

None of those powers, none of those handles, none of those empowerments that make all of us, if you will, help the EPA to enforce the law and extend the law. None of that exists in the Safe Drinking Water Act. And I don't think it's really a matter of industry. I mean, really. Big industry is much more concerned about air pollution than water pollution, believe me, in terms of the price they have to pay, but they've got a much, we've got a much better law. And I think in many ways, we could re-pattern the Safe Drinking Water Act based on the successful experience we've had with the Clean Air Act.

Bill Glovin: Can you speak a little bit to what motivated you to study this area?

Ellen Silbergeld: Well, I think it was when I first came down with the School of Public Health at Johns Hopkins, with my freshly-minted engineering degree, and was trying to move myself closer towards public health, and I became aware ... Keep in mind, I'd been studying engineering for four years, that there was still a very large lead problem in Baltimore, and this kind of surprised me.

Then I started to look into what it was all about, and I was told it was very dangerous, particularly for children, it impacted the brain. But nobody seemed to know how lead actually affected the nervous system. So that seemed to me just the kind of problem I always look for in my career, which is something that is scientifically challenging, that is important in terms of public health, and where really research can make a difference.

Bill Glovin: Do you have any current research project going on or interest that you want to tell us about?

Ellen Silbergeld: Sure. Almost in the same way of suddenly becoming aware of something that I had never thought of, a lot of my research right now is looking at why we have so much antibiotic-resistant bacteria in the food supply? How does that come about? And again, when I started to look at that, it seems like nobody was paying a lot of attention to this problem. Except someone said to me as I began to explore it, "You know, they feed animals antibiotics."

Now I was an engineer who had studied neurotoxicology. Didn't know a whole lot about bacteria, but even at that moment, I thought to myself, "That can't be a good idea." So once again, it seemed to be one of those areas that could be potentially really important. Nobody was doing any work on it. And again, maybe some research could be helpful, so that's been the current focus of a lot of our work.

Bill Glovin: Dr. Silbergeld, I really want to thank you again for a great article. I think a lot of people are interested in this topic, and I think this podcast will help even further in enlightening people. Thanks again. And thank you, the listener, for tuning in. Join us next month when we talk to Shekhar Saxema of the World Health Organization and Patricia Marquez of the World Bank on a collaboration between the two organizations to improve global mental health. Our article, Water and the Developing Brain, and all our other *Cerebrum* articles, plus the latest advances in hot button neuroscience issues, and a treasure chest of resources, can be found at Dana.org. That's D-A-N-A.o-r-g. See you next time.