Fluoride 2

Firsthand Fluoride 2: Ouch! It's 1964, and I'm at the fight of the century, and I just lost. I got my tooth pulled. And why did I lose my tooth? I didn't really know then, but I do now. It was bacteria versus fluoride, and I didn't have any. It was bacteria poop, to be exact. Acid. I'm eating candy. My mom doesn't really know how much. I'm eating cereal that's called Sugar Smacks or Frosted Flakes with a sugar bowl that we got to use sugar. 'cause my mom was sleeping, and we didn't wanna wake her because we were five kids and my mom needed her sleep in the morning. So, hiding in plain sight in 1964 was fluoride. It had just entered the water in New York City. And it was in some toothpaste. Lord knows if I brushed my teeth, I can't remember. We probably did, but we certainly didn't have fluoride treatments at the dentist. And so why did I lose my teeth at that time? Because it's not one thing. It's not one quantity of one thing. It's an approach to health: reasonable amounts of sugar, fluoride in the water to build the teeth strong.

And I know that. And why do I know that? Well, I don't remember if I said this is Raphael, and it is, but this is Dr. Santore, also. In 1974, about 10 years after I got my tooth pulled, I went to dental school, and I learned a lot about how to fix broken teeth. I didn't learn as much how to keep them from getting broken, how to keep them from getting decayed. That came with time and maturity. And after 45 years, I have a lot of stories, but I only want to tell you one or two. So what happened in 1980? I was treating patients, and I was finished with all my residencies and things, and I noticed that I would fix teeth that had cavities on top of the fillings on top of the teeth that just had cavities. Boy, that lactic acid and all those things that bacteria produce and they erode teeth, were working really hard against me. And I started to see a change in the late '80s and in 1987, Willowbrook closed. And that is where we saw lots of patients who came to the hospital I worked at where I did anesthesia and taught pediatric residents how to do dentistry and how to think about healthcare for the handicapped. And we saw over about 10 years before Willowbrook closed and even after, while we were treating the handicapped in the larger New York area, mostly Brooklyn, but larger New York area, that the kids were getting less cavities. We started speaking to the parents and we start looking at the data, and we realized that there was a revolution, that the bacteria was starting to lose the battle. Now, we weren't quite sure why. It seemed common sense that people brush their teeth, but it had to be more than that because the handicapped kids could not brush their teeth well. Their parents were always exhausted, caring for them, and it was a difficult environment. In about 1991, varnishes came out that we dentists could use in the teeth and before we put the restorations in them.

And in 1996, my son, my firstborn son, was six years old and he had no cavities. And I noticed because I treated the kids in his class, that they had no cavities. And I started to put together the relationship between good healthcare and systemic fluoride as well as topical fluoride. And they do different things. And we argue to this day about which one is better, and they are both important. But the thing about systemic fluoride is it's the quiet giant that works behind the scenes, and that's what I came to realize as a dentist in the trenches, so to speak, trying to prevent teeth from being destroyed. In the year 2025, I can tell you, without a doubt, from treating different communities with different advantages and access, that fluoride in all its forms properly used is a gift to children. And I share that with every parent that comes in, and I show them x-rays. I have so many x-rays that show such a long history that we went from decay and fillings to [00:05:00] very little decay or almost none and no fillings. And I thank you for listening to this and I hope you heard a simple message with all the honesty that I meant for you to have and to hear. Thank you.

EW: love that.

EAU: It's so good.

EW: Ray, Thank you so, so much. for sharing that with us.

EAU: Thank you

EW: the best, the best. A man who goes by many names

EAU: Mm-hmm.

EW: Raphael, Dr. Santore, uncle Ray, my husband's Uncle Ray. So, um, but I really did appreciate that perspective of like, here is a noticeable difference. You know, I feel like sometimes big public health measures, we don't see the impact Right? away, or we only see the impact when they're taken away. But I love that, with that additional fluoride to the water, it was like, here is a very clear night and day difference.

EAU: We can really see the effects and from someone who's on literally the front line of it. Right. Seeing teeth day in and day out.

EW: Yeah. Ugh. Yeah.

EAU: appreciate it.

EW: Super, super appreciate it. Hi, I'm Erin Welsh,

EAU: And I'm Erin Allman Updyke.

EW: and this is, This Podcast Will Kill You

EAU: Part two of fluoride,

EW: part two. Yeah,

EAU: it's, it's on me today.

EW: I am just thinking how weird it is and like, I don't know if I, I don't know if it's like nice if I'm like comfortable not having anything

EAU: Right?

EW: You know,

EAU: nothing to hold and to be like, reference.

EW: I mean, it's, I get to just like sit back and relax

EAU: liked it last week. Um, would love to do more of those. I'm very nervous about this week, but, so last week, if you missed it, we went through Erin Welsh, went through the history of fluoride, how we figured out what it does when we started putting it in our water slash when it was always there,

EW: When we, yeah. When we stopped putting it in our water in some places. Yeah.

EAU: And the history Yes. Of the anti fluoridation movement. So today I am going to talk to us about, honestly, Erin,

EW: Yeah.

EAU: this is going to be just a very long-winded episode for me to end with essentially the same conclusion that you stated last week, which is that as of right now, there, there is no data of harm to our health from drinking water with fluoride added to it at the specific concentrations that we add to it.

EW: Right.

EAU: it's, that's uh the TL;DR

EW: TLDL?

EAU: TL D Listen. Yep. There you go. But let me tell you, it took me a very long time, quite a lot of research and a real emotional journey, uh, to get to that conclusion. So,

EW: Okay. I'm curious about the emotions, number one. Number two, I think that that illustrates how challenging it can be if you have questions to get to the bottom of those questions.

EAU: hundred percent. A hundred percent. But we will do our best to do that today with first going into some detail on like what a carry or a cavity, like we talked about last week, really is how it forms.

EW: question. Is it a caries?

EAU: I don't know, Erin. I still don't know. And I am probably just gonna call it cavity, because that's my word.

EW: Okay. I'm

EAU: A carries seems so weird.

EW: I know I kept, I kept trying to like adjust the verb noun

EAU: like a dental caries. Okay. How dental carries form. How about that?

EW: Had dental caries forms, but

EAU: What?

EW: then is there a plural of

EAU: No, no, Carries is the

EW: the singular of Carrie's?

EAU: Ray, help us out.

EW: Yeah. We need some, we clearly do. I think it's like deer and deer,

EAU: Know that. I can't accept that because

EW: it might

EAU: on the end, but caries is plural.

EW: And singular.

EAU: Whatever Erin, listen, we're gonna talk about how they form, how fluoride actually works to protect against the formation of dental caries, where we're getting that fluoride from, and then of course all of the controversies, if that is the right word, um, about the supposed or possible negative health effects of fluoride. Okay? That's what we're gonna talk about today. But first.

EW: But first it's quarantini time. We're drinking the same thing we did last week, and that is, um, pulling

EAU: pulling teeth. Yeah. Okay.

EW: Um, we don't quite remember the ingredients, but that's okay, because you know what? look it up. It would've been so easily accessible in my notes. Um, but that's okay, because you know where you can find that

EAU: On our website, this thispodcastwillkillyou.com or our

EW: of our social media,

EAU: we're there. Instagram, this podcast will kill you. Blue sky, the, I don't remember our

EW: T-P-W-K-Y or this podcast will kill you.

EAU: Facebook, we still exist there. Uh, TikTok [00:10:00] also, you know what I mean? Just, just follow us.

EW: check it. Check it

EAU: There's mint in it. There's elderflower. It's like a, it's delicious.

EW: Um, let's, let's do a web, a website spiel. We've got, um, transcripts. We've got sources because I know that you're gonna wanna read up more on

EAU: Woohoo. Yeah. You are.

EW: And we've got some, we've got some sources. We've got a link to where You can submit your firsthand account. We've got links to the books that we feature on these episodes and our book club episodes, um, and more things. That was a terrible website spiel,

EAU: You did your best,

EW: it, thank you. All I, that's all I can do. That's all I can hope for.

EAU: rate review and subscribe on your favorite podcatcher. Uh, you

EW: We're on YouTube.

EAU: YouTube. The

EW: go. Let's go.

EAU: Okay. Uh, after a break, we'll do it.

EAU: I just wanna also set the stage really quick,

EW: Okay.

EAU: uh, and remind us of what a global public health problem dental caries are. Um, I'm gonna use them as a plural. Uh, the.

EW: are, it's both a plural and a singular. So you're, you're in the

EAU: Okay. I cannot get it wrong. So the World Health Organization estimates, and this is a little bit old data, but it's still what is cited, that 2.4 billion people across the globe have untreated dental caries in their permanent teeth, and 621 million kiddos have untreated dental caries in their primary teeth. So this is a huge public health problem. There was a really great nature review, nature Reviews disease primers paper from 2017 that I used heavily for the caries

section. And it estimates that 60 to 90% of children, and the vast majority of adults are affected by dental caries at some point in their life. And they're actually considered the single most common chronic childhood disease. Like what?

EW: I mean, I'm not, I'm not surprised.

EAU: I know and like many chronic and infectious diseases, we do see disparities in prevalence as well as access to care with children of color and children in lower income areas, having significantly higher prevalence and difficulties and access to care. Although globally it is still the case though this is changing due to dietary changes. Higher income countries actually tend to have slightly more carries than lower income countries. So that's largely dietary differences in how much sugar we eat. Okay. And that's the end that I'm gonna say about sugar. 'cause today is about fluoride. Okay, let's talk about how dental caries form. There's two main components that exist for the formation of dental caries. First is issues with the enamel itself, and the second is the components of the oral microbiome. So let's start there. Our oral microbiome is just so varied. We have so many different things that live in our mouth. We've got bacteria, yeast, viruses, protozoa, even ArcHa. Did you know that?

EW: I did not know

EAU: neither.

EW: How did they get

EAU: How did they get there? Many of these organisms are commensals or even beneficial to our mouth and to our health, but some are what we call cariogenic and all of these helpful and unhelpful organisms. 'Cause I can't just say bacteria. It's more than just bacteria. They live together and they grow and form this very complex biofilm on our teeth surface that we call plaque.

EW: Plaque.

EAU: And each surface of each one of our teeth is its own little microenvironment with its own little microbiome.

EW: So There's like

EAU: like your whole mouth and then there's like each little surface of its tooth. It's gonna be a little bit different.

EW: Yeah,

EAU: Isn't that great to think about?

EW: I am very curious. Okay. And, and So. I assume that there's like a fairly there, that there's a gradient from front to back too. Like if you're closer to the back of your mouth, what's going on there

EAU: have no idea. What a fun, we should do a whole episode on the oral microbiome.

EW: really we should though, and like flossing,

EAU: listen.

EW: talk about

EAU: You know that we've talked a lot about floss. You and

EW: We, you and I talked a lot about, more than you would expect,

EAU: know. Okay, but listen, we're, let's get back to the oral microbiome in the context of caries.

EW: et cetera.

EAU: So under certain environmental conditions, for example, high concentrations of fermentable carbohydrates like sugar or conditions like say a reduction in saliva. We can see a shift in this microbiome to favor certain bacteria, including various species that are more either acid producing, so they make more acid [00:15:00] from these fermentable carbohydrates, or they're just very tolerant of this acid. And it's not just like one or two species of bacteria. We used to think it was just like maybe a couple different species that were the main like causes of dental caries. It's not. It's this whole ecological community that shifts to favor acid production. And that is the first step in the formation of dental caries is this shift in the oral microbiome to favor acid production. And we most often see this due to things like regular exposure to sugars. Okay?

EW: so we've got the, the first thing, like the, the inciting incident is the sugar, and then that just sort of selects for this ecosystem that is acid

EAU: more cariogenic. Then we have the hard stuff, our enamel. So as the acid production from these bacteria starts to build up in our mouth, the pH of course is going to drop. Acid has a low pH, and that drops the pH at the surface of our enamel, which is the outermost part of our teeth that surrounds the dentine. Right?

EW: Mm-hmm. Mm-hmm.

EAU: Enamel is mostly made of a substance called hydroxy appetite, which is basically just a compound of calcium and phosphate and hydroxyl, which is like oxygen and hydrogen. And in the presence of acid, what happens is that this becomes soluble. So it there's a partial demineralization of this outer surface of the tooth, and as this hydroxy appetite starts to demineralize. Then you have an increase in porosity, right? So then this acid can diffuse even deeper and cause further demineralization releasing more calcium and more phosphate from this enamel, right? And this process, don't ask questions yet. Erin, I can see You take a breath.

EW: teeing up. Yeah.

EAU: This process and, and the fact that like we have saliva in our mouth, which serves as a buffer, eventually we're gonna wash out some of this acid. Eventually you will have remineralization, right? Because the calcium and phosphate are being released, your saliva is coming into buffer and eventually things even out to where the calcium and phosphate are gonna redeposit. And you can remineralize this unless. You can't, because if you continue to have acid production, if you don't have enough saliva, et cetera, then this demineralization process can continue until you end up damaging the pulp of the tooth, which can then damage the canal, the root canal, and then you end up needing a root canal or an extraction. But this process demineralization and then remineralization mineralization. It's a hard word to say. This is happening in our mouth all the time. I think that we think of our teeth as like static, right? They're just like little bones sitting in our mouth, but they're not, they're alive and they are constantly changing in response to the environment of our mouth.

EW: Um, okay. Can you tell me about why low Saliva is bad?

EAU: Saliva is a buffer in our, in that acid base system. And so without the saliva, then you don't have that buffer. Yeah.

EW: And then why,

EAU: probably more also, but that's the short answer.

EW: why acid? Like why do these microbes produce acid? Is it like a competition thing with other

EAU: that's

EW: just to kind of like stake out more space and claim? I

EAU: a deeper dive. I don't know. Is it just that that's like a byproduct of the production of sugars? That's what it seems like. It's like they produce mostly lactic acid as a result of the production or the digestion of sugars. So it's just like their poop.

EW: Right, right. Yeah.

EAU: Okay. But that's just like, all of that was just dental caries. That's just what's happening in our mouth. Where the heck does fluoride come in? I haven't even said the word fluoride yet. Hmm. Let

EW: lurking in the background.

EAU: It is. It is Erin. So it is, like you said last week, Erin, you kind of went into this fluoride is it's just a mineral salt that's present in our environment. Like all of us are being exposed to fluoride through various sources. Fluoride is like the ion form of fluorine. The the element, which is I learned the 13th most abundant element in our earth's crust. Like it's just there. It's around. It's in a lot of different mineral compounds and it's absorbed very well via our GI tract when we are exposed to it. But how does it work in our teeth to protect them from dental caries? There are several mechanisms that we know of. Now how fluoride works. First is that it delays that initial demineralization process. Basically fluoride itself, you can think of as acting like a buffer. It because of when fluoride precipitates versus become soluble compared to calcium phosphate, that's, and the hydroxyl groups that's in hydroxy Tate, [00:20:00] in the presence of fluoride, you have to have a lower pH, a more acidic environment before that demineralization starts. Does that make sense?

EW: Yeah. Yeah, yeah. It like lowers or it, it raises the bar

EAU: Yes.

EW: like, you gotta be even more acidic if you wanna do damage

EAU: exactly. Exactly. And then on top of that, again, because of the chemical properties, it also hasten that process of remineralization. It returns that. Neutral pH faster to favor remineralization. Right? So you're like less demineralizing and more remineralizing.

EW: Wow. Okay. So it's like a twofold. It protects you and it also helps to repair

EAU: Exactly. Yeah. And there are more mechanisms too. Um, it also can interfere with like the bacteria themselves that form this biofilm. They can, uh, fluoride can interfere with glycolysis. So some of the specific like metabolic processes in that bacteria that live in our mouths, especially those cariogenic ones, so that they're just not as efficient. Um, it's thought that this is probably not like the most important mechanism, but it is yet another mechanism by which fluoride is helping the oral microbiome of our teeth, which is cool. And all of these events happen even at very low levels of fluoride in our mouths, like less than one part per million at high levels of fluoride. It can also penetrate through the plaque and then be incorporated into our enamel itself. So instead of that hydroxy ate, you can have fluoride there instead of the oh group. So it's called fluoro ate. Did you know that shark enamel is made almost entirely of fluoro ate?

EW: all, all shark, like what

EAU: don't ask me more details, Erin.

EW: It's like, is there a lot of fluoride in salt water in the

EAU: There's like one to 1.5 parts per million in saltwater. So n nah, not really. I mean, there's some, yeah. Um, yeah, so that, that's some of the other ways. And like we talked about last week, Aaron. If we are ingesting fluoride systemically in our water, in our food, whatever pre eruption IE, when we are little before our first teeth pop out, it also has been shown to make our enamel more resistant to the development of caries later on. Especially the deep crackly bits of our teeth that aren't ever going to be exposed to topical fluoride

EW: Ah, okay. And this is both for, uh, baby teeth and permanent teeth.

EAU: All these mechanisms. Yes. Yes, a hundred percent. And I wanna actually stop here for a second and take a pause because this already what I have said is one of the points that many of the papers and the rhetoric that pushes back against the idea of community water fluoridation really tends to

stick on because it is true. And we talked a little bit about this last week. We know now that the primary mechanism of action of fluoride is actually topical. So it is what is happening in, on and around our teeth, in our saliva, in this dental plaque, et cetera. There are though these s so-called systemic effects in that there is data, pretty clear data, that there's a pre eruptive benefit to having exposure to fluoride before your teeth even form. But the primary way that it works thereafter is by existing in our mouths and around our teeth.

EW: right.

EAU: But when you really then think about all of the different ways that we could be then exposing people to fluoride, that fact that it is topical, that it is low levels, that it is a constant exposure, actually favors water fluoridation because we're drinking it multiple times a day, every day, compared to, say, milk or salt fluoridation, which are other more targeted strategies that other countries use for like large scale fluoride distribution, right? Because drinking it in our water is this constant low concentration flow, plus then anything that's absorbed systemically is then going to be re-seed into our saliva, although at even lower levels, right?

EW: Right, right. I mean, it's, it's that the fact that it's, if it's, if you're drinking it, then it's sys, then you have the systemic fluoride in your saliva bathing your teeth in fluoride.

EAU: It's also when that water is in your mouth, so it's not just like having to be absorbed by your GI tract. It's also every single time I've been swishing my water a lot more since reading about this. That's probably ridiculous, but really?

EW: yeah. Okay. So I have a question about the development of teeth

EAU: Oh gosh, Sharon. Oh no. Erin, ask me questions about things I didn't research. Okay, go

EW: I mean, take it away. [00:25:00] Like when do teeth develop?

EAU: I mean, I pass.

EW: Okay. I'm sorry, I was just thinking like at what level, at when is exposure to systemic fluoride, um, for tooth development? Like really, what is that critical time

EAU: Yeah, I don't know.

EW: Okay.

EAU: I didn't see the specific data on that. They all just say like, pre eruptive,

EW: Pre

EAU: because I think like by the time, so like six months to 12 months is when your first baby teeth usually start to appear. Um, and then the obviously adult teeth, you start to lose your baby teeth usually by six years old is like the earliest, sometimes a little bit earlier. Um, so it's sometime in that timeframe, like before the eruption of especially your adult teeth. Um. Yeah, I don't, I don't have an answer to that, Erin.

EW: Okay.

EAU: Uh, okay. But so what are the different ways that we have used this knowledge that we now have about how effective fluoride is and the ways that it's effective to prevent dental caries? What are the different ways that we've been using this to improve public health? And you kind of set the stage for us for this a lot last week, Erin. In the US community, water fluoridation is the way that we, as a society, I guess, I don't know, as a, what's the word? Yeah. Country is the word I was looking for.

EW: Okay?

EAU: It is the way that we as a country have decided to do. Oral health, right is community water fluoridation. We've been doing it for almost 80 years. It's had tremendous and very measurable public health impacts, and it is not just the US Countries around the globe have been using widely administered fluoride for the prevention of dental caries for a really long time. Some countries, instead of using it in the water, have decided to use milk supplementation the way that we fortify milk with vitamin D in the us. Other countries have used salt, like the way that we fortify salt with iodine here in the us Are we sensing a theme here? And then Community water fluoridation or CWF is the most widespread. It's covered an estimated 400 million people in 25 different countries worldwide.

EW: it's actually less than I thought.

EAU: Hmm. Okay. I mean that doesn't account for everyone who just gets it from naturally fluoridated sources, which we'll talk about. Um, but I also just wanna do a plug real quick here and I have a paper to back this up, that our water fluoridation systems are very, very impressively good at keeping the

concentrations at that 0.7 parts per million or milligrams per liter, that they are expected to like better than I expected, honestly, like very, very good at it.

EW: and I think that's a talking point of some anti fluoridation is where they're like, they're not really measuring the water.

EAU: No, they actually do a very good job of it.

EW: yeah, yeah.

EAU: The US Public Health Service and the a DA report, their estimate is that drinking fluoridated water at the level that they recommend, which again, I'm gonna say this a million times, 0.7 milligrams per liter, which is the same as parts per million, reduces dental caries by 25% in children and adults.

EW: Mm-hmm.

EAU: That number already is now contentious because recently some papers that have tried to look at like what is the benefit just of fluoridating our water specifically in more recent years since the advent of other dental hygiene options, like we didn't use to have Fluor data toothpaste, we didn't use to have fluoride, sealants, et cetera. So some papers that have tried to look just at more recent data estimate a lower benefit, maybe like a three to 4% reduction in caries, and this is based on a Cochrane review that came out last year as well as a paper out of the UK that looked at like 10 years of UK data.

EW: Mm-hmm.

EAU: But at the same time, other recent papers, including one out of Australia from 2017 and one out of Brazil in 2021 actually had much higher carie reduction estimates from their water fluoridation. So. We don't know the exact amount, but the data is clear across the board that there is a reduction in dental caries. And every paper that has looked at the financial impacts consistently finds that community water fluoridation is a cost-effective intervention, even when it's impacts are less. Okay.

EW: Okay. So I just, I really want to understand why there are such discrepancies and so like historically, those numbers were much higher even than 25%.

EAU: I mean, even the Brazil paper from 2021 at like was a 50% reduction, so

EW: So what, [00:30:00] what can account for that three to 4%?

EAU: I don't know. In all honesty, Erin, I mean, is it just that we have so many other options that are doing a very good job and so we've seen, I, I don't know. 'cause it's not like we've seen reductions in carries, like carries are, if anything on the rise. So I don't know. I don't have a good answer for you. I just can tell you that that is what the data shows.

EW: Yeah.

EAU: So we, we grains of salt, all of this. Okay. But consistently a reduction and like what level of reduction in carrie's prevalence do we have to hit for this to be considered important if we know that it's cost effective? That is like so far beyond my expertise. Right. This is like, these are the big questions.

EW: I mean, it's still, it still to me comes down to the fact that like, this is a community public health approach, versus you have to go, go, then go to the store and buy mouthwash and buy the Right. toothpaste and go to the dentist and all of the things that cost a lot of money. Whereas Fluoridated Water, it's just, Yeah.

EAU: Yeah. And I will

EW: like a reasonable solution.

EAU: doesn't it? And so that's what we've decided. Okay. So now we have to get into, what I know that everyone probably really wants to know is there's a lot of people talking about that fluoride is actually quite harmful to us. So what does the data show? What are the risks, if any, of having fluoride in our water? There are only two potential harms that are worth talking about in detail today. So that's what I'm gonna focus on. But I do just wanna point out that there are an endless array of things that fluoride has been blamed for and continues to be blamed for. Kidney dysfunction, kidney stones, bladder cancer, all cancer, sex hormone disruption, A DHD, diabetes, liver dysfunction, infertility, musculoskeletal pain. Throw a dart at your pathophysiology textbook. Someone has made a claim that fluoride has caused it

EW: I mean, what last week? What did I say? UE financial

EAU: financial distress, which there's actually data that fluoride in the water, um, people work more and they, they have better income and stuff. There's some papers that say that, which is so interesting.

EW: mean, I, yeah, you're not having to go to the dentist to like for emergency dental carries repair all the

EAU: Yeah. So what does the data show? Okay, let's, let's look at this.

EW: Yeah.

EAU: There are some things that we know for sure. Um, there is very consistent evidence of absolutely no association between fluoride exposure and cancer or cancer related mortality or bone cancer specifically, or hip fracture or down syndrome or kidney stones. So that we can say definitely no association.

EW: no association.

EAU: Thyroid dysfunction is another thing that people say is caused by fluoride. There is really limited evidence for any association one way or another. There are papers, some of which show an association, some of which do not show an association. At this point, we cannot make any solid conclusion for thyroid dysfunction and most of the rest of these claims. There is simply no data to even evaluate these associations, which just means that anyone who says that these associations exist is lying. It does not mean that for sure. There's absolutely no way that this could ever be related, but there, there's literally no data to support these ideas. Okay. But there are two outcomes that are worth digging into a little bit more because of the wealth of information that we have on the subject and all of the controversies that exist right now. And those two are skeletal, fluorosis,

EW: Okay.

EAU: and impacts on intelligence as measured by iq, but which is often conflated as just this blanket idea of neurotoxicity.

EW: Mm-hmm.

EAU: So let's get into these two, shall we?

EW: I'm very excited for this.

EAU: Yeah. Excited is not the word I would use.

EW: I am. Yeah.

EAU: It's fine. I, it's excited. We're excited. Listen, skeletal fluorosis. Okay, Erin, you talked to us a lot last week about dental fluorosis, and that is when we're exposed to a lot of fluoride and then our teeth get mottled enamel from it because of the fluoride actually accumulating in our teeth. So much like fluoride can accumulate in our teeth, if we're exposed at high levels, it can also accumulate in our bones and this can lead to deficient mineralization essentially because fluoride is getting taken up in our bones instead of the other minerals that would normally get taken up in our bones. So then you just have a change in your bone structure and potentially weaker bones. Now remember that we have very strong data that there's no association between community water fluoridation and hip fractures, which was one of our main metrics to look at like the strength of bones. Okay, but skeletal fluorosis is something that definitely can happen and does happen. It generally [00:35:00] happens at long-term intakes of six to 14 milligrams of fluoride or more per day.

EW: Okay, so what is that in terms of parts per million? Like what does

EAU: we, should we Erin math a little bit? I can't wait. Okay. If you, this is Aaron Math trademark. I could be wrong, but I did the math. Okay. If you got all of your fluoride from drinking water in the US from optimally fluoridated sources, then you would be drinking water that was 0.7 milligrams per liter or parts per million.

EW: Okay.

EAU: You would have to drink eight and a half liters of water per day if you got all of your fluoride from water. You would have to drink eight and a half liters of water per day just to get six milligrams of fluoride in your diet. I don't know about you, but I can't even get myself to drink two liters, eight and a half liters of water per day. That would not be a healthy amount to drink. Okay.

EW: Right. And so the, just remind me again, the range that leads to that is suggested to lead to skeletal fluorosis.

EAU: six to 14 milligrams per day puts you at higher risk of skeletal fluorosis. It does not mean that you will have it, but ingestion of six milligrams or more per day puts like at a population level, some people are going to end up with skeletal fluorosis.

EW: Okay.

EAU: Now no one is getting 100% of their daily fluoride from water. It's estimated that in the US we get like 40 to 70% of our daily fluoride intake from our water and the rest from other bottled beverages. Food, black tea has so much fluoride in it. Who knew? Yeah. Um, and you know, toothpaste, especially our kids who are just like chugging that stuff,

EW: yeah. Yeah.

EAU: it's so annoying that they do that personal. Yeah. Yeah. Why do they make it so delicious?

EW: Is it

EAU: No, but they think it is. It's like bubblegum flavored and it's so gross. Anyways.

EW: Bubble gum flavored toothpaste grosses me out.

EAU: Yeah, you would say, but I buy it. If you assume then on the low end that you get 40% of your fluoride from water, we can Erin math this as well. In order to get to that six milligrams a day, you'd have to still be drinking like three and a half liters of water, 3.4 liters of water, and somehow getting another 2.6 milligrams from somewhere else. And you'd be hard pressed to get that from your other dietary sources. Dr. Eating a lot of toothpaste, I guess might get you there. So the math just does not work out. And there are some pretty large meta-analyses that have estimated like what does water have to be at for someone to have an increased risk of skeletal fluorosis from their drinking water? You've gotta be. Right. You've gotta be looking at higher than 3.7 to 3.8 parts per million in your

EW: if you were getting something from like a deep, well that has not been evaluated for.

EAU: you definitely could be drinking that. So realistically, bottom line skeletal fluorosis is not something that is a concern from drinking water at the levels that we see in optimally fluoridated water systems.

EW: Question. How is skeletal fluorosis diagnosed?

EAU: Oh, that's a really good question. I don't actually know the full answer to that. Yeah.

EW: so do we know the prevalence of skeletal

EAU: No. In areas that like the highest prevalence in areas that have like really high levels of water fluoridation, I've seen like maybe 10 or 11, 12%. Um, but like across the globe it's pretty low. Um, but it certainly is a risk in areas that have really high fluoride levels. And I think there are probably some population somewhere that have much higher levels than that. Um, but I don't have like global estimates or anything now.

EW: would be like in areas where you see. Um, higher, like maybe there are geographic areas with higher hip fractures than you might suspect that there's higher levels of fluoride in the drinking water.

EAU: I, I don't know that I would even go that far, honestly. Yeah, I I don't think that we have any data to support those kinds of estimates. No. Yeah. Um, now on the other hand, mild dental fluorosis, which again, dental fluorosis you get from having higher levels of fluoride in your water. We do still see some degree of mild dental fluorosis, which is, it's considered mild if it's not enough to cause significant cosmetic concerns, but like a dentist would see it on your teeth. Um, depending on the study, there's some estimates of like 10 to 12% of the population in areas that are like optimally fluoridating their water can still have a mild dental fluorosis. So that is real, but that's, it's not real for skeletal fluorosis at the levels of optimally fluoridated water.

EW: It's not like having health impacts, it's having teeth like the, the appearance of teeth of your teeth.

EAU: And only in a small proportion of the population.

EW: Right, right, right.

EAU: Correct. [00:40:00] Um. So now a very quick diversion, uh, a little bit more numbers before we get into the possible neurotoxic effects of fluoride, because these numbers are going to get really important 'cause, uh, surprise, surprise. We need a little bit of nuance here. Okay?

EW: Mm-hmm.

EAU: I've said a hundred times already. The US Public Health Service recommends that if communities are going to add fluoride to their water, they do so at a level of 0.7 milligrams per liter, or parts per

EW: Parts per million. Yeah. Okay.

EAU: the EPA, which is the body who is in charge of regulating and enforcing standards for things like our drinking water.

EW: Mm-hmm.

EAU: Their standard for the maximum amount of fluoride that should be in our drinking water is four milligrams per liter. That is the level at which they can actually enforce something. Their recommended maximum is two milligrams per liter, but it's not actually enforceable. So if a community, for example, has fluoride naturally occurring in their water between two and four, the EPA can be like, Hey, listen, that's a little high, but they cannot do anything about it unless it's above four.

EW: Okay. This, this brings to mind a question about the fluoridation laws that are currently being, or anti fluoridation laws that are currently being discussed or have already been passed, like in Utah and Florida. Um, if there is naturally occurring fluoride, and this is, maybe this is like a question that maybe you can't answer, but if,

EAU: but it, it is the question, Erin.

EW: It is. It is the question, if there is naturally occurring fluoride in one of these states where Fluor, you're not allowed to add fluoride to your

EAU: Uh huh

EW: is there anything done to reduce the fluoride in that water?

EAU: That, that is the question because it also is who is checking it and who is enforcing those regulations, right? Because the EPA is in charge of detecting this and of enforcing these regulations, what teeth do they have to be able to enforce those regulations? The more that we defund the EPA, what ability do they even have to be doing the water testing that they need to be doing to make sure that our fluoride is at a safe level, especially in places with naturally occurring fluoride?

EW: I'm sure a corporation would love to, you know, hop in and charge a great deal of money for

EAU: That's a great idea, erin. So listen, for what it's worth, the World Health Organization recommends that drinking water should have no more than 1.5 milligrams per liter. That's their maximum. That should be allowed in drinking water. And they say that for any place who is adding fluoride for community water fluoridation, they should do so at a level between 0.5 and one milligrams per liter.

EW: Okay.

EAU: And these numbers, especially that World Health Organization recommendation of no more than 1.5 milligrams per liter, that number is important. So keep that in your brain. Okay.

EW: Yep.

EAU: Back in 2015, so like a decade ago now, the recommendation in the US for optimally fluoridated water was a little bit different. It was like a range. You could go anywhere from 0.7 to 1.2,

EW: Okay.

EAU: then because of the incidence of dental fluorosis being higher at levels above one, they decided to lower it to 0.7 back in 2015. That same year is when they established a task force through the NIH, actually not the CDC, but through the National Toxicology Program to look into the effects. Fluoride on neurodevelopment and specifically on iq.

EW: Okay.

EAU: The results of that have now been published just this year. Okay. There was a monograph by the National Toxicology Program that came out in August, 2024, and then in January of this year, a like subsequent, like an additional meta-analysis that was published in JAMA Pediatrics.

EW: Okay.

EAU: So I'm gonna tell you the conclusions of this study, Erin.

EW: Yeah.

EAU: is a dose response relationship between exposure to high levels of fluoridated water and lower IQ scores in children. Plain English

EW: Yeah.

EAU: kids who are drinking water that has higher levels of fluoride, specifically kids who are drinking water with more than 1.5 milligrams per liter of fluoride

EW: Mm.

EAU: may have slightly lower IQs than kids who are drinking water with less fluoride. And it's like, it goes up with the amount of fluoride above 1.5 milligrams per liter.

EW: Above 1.5 and there's a, like the more fluoride, the higher the reduction in iq, which as we maybe know is not a, the best metric for things, but it is a [00:45:00] metric. Yeah. Do you have thought, do you have

EAU: There's so much, there's so much that I and bursting to say and it's ha, it's hard. Okay. Um, and. I cannot get too in depth on the exact effect size of this because we don't have those exact numbers from drinking water itself. Like what is, what are we talking about? How much of, of a reduction in iq? They didn't actually estimate those numbers from drinking water, but they also looked in this meta-analysis at urinary fluoride, um, which is, it's a little bit problematic to use because we excrete most of the fluoride that we drink in our urine, but the like concentrations are gonna vary depending on the time and how much water you drink and blah, blah, blah. But in any case, for every one milligram per liter increase in urinary fluoride, we saw in this meta-analysis a 1.63 points decline in iq.

EW: Okay? And just again, to like set the, just so that I understand this is in, okay, maybe I'll phrase it this way, which communities in the US have water that's higher than 1.5 parts per

EAU: Before I can even get into that, Erin, none of the studies that were in this meta-analysis were in the us. None of them, almost every single study that was included in this meta-analysis were done in places that had naturally high levels of fluoridation. None of them were in places that were adding fluoride to the water at optimum fluoride concentrations. A lot of the studies that were, a lot of the studies that had, you know, like low fluoride versus high fluoride, their low fluoride concentrations were actually at levels that are consistent with what we

consider fluoridated water. Right. Because like across the board, everyone's got higher fluoride, so high fluoride was like above two and low fluoride was like 0.5 to 0.8. Okay. I know this is so, it's too much.

EW: no. No, no, no, no. Okay, so, so this, this, this review, this meta ana, or this, I guess this, this task force that was established in the

EAU: Yeah. Part of the National Toxicology Program. Yeah, I, I guess, I don't know if it was a tech task force feels official, but yeah.

EW: Okay. Okay. But the, and there was not a single study that it was included, that was done, that was based in the uS looking at water. That is community fluoridated in the us.

EAU: no. Another meta-analysis from a couple years ago published in 2023, which one could argue, might be more relevant to the question of like, is fluoridating our water to 0.7 parts per million potentially harmful? Found no reduction in IQ between UN fluorinated water, which had an average fluoride concentration of 0.2 parts per million and optimally fluoridated water, which was at 0.7 parts per million. And if you look at this, that is actually entirely consistent with this newer meta-analysis from 2025, because all of the data in this meta-analysis showed that there was a potential for reduction in IQ at levels higher than 1.5. There was no association seen for IQ at lower levels than 1.5 milligrams per liter. That association broke down and fell apart. There was no data to support it in this large meta-analysis.

EW: so if you're looking at a graph of this, maybe this is a terrible thing to do on a, on a podcast, but hey, we're video now, not that I'm just gonna use my hands, but if you're looking at a graph of this, and on the x axis, the bottom, it's fluoride levels in the water, and it's a, and the, the on the Y axis is like the reduction in iQ or something. Yeah. It's a straight level from zero, from like no fluoride in the water. All the way past where the 0.7 optimally fluoridated water keep going. Still straight line until you get to like

EAU: 1.5. Yeah. Above

EW: then, and then it starts to, you know, change. Okay.

EAU: That's the conclusion. Erin,

EW: So

EAU: uh, you asked, sorry. Uh, you asked earlier, um, how much, how many people are getting more than 1.5? Okay. In the US it's estimated that 2.9 million people are served by groundwater or private wells that have concentrations greater than 1.5 and several hundred thousand having concentrations higher than 2.0, which is again the EPA non enforceable, maximum recommended, or even some above 4.0, which is above what is even supposed to be enforceable by the EPA globally. It's estimated that 57 [00:50:00] million people at least receive water that is naturally fluoridated, which means who? Hecken knows what the concentration of fluoride is, right.

EW: Right, right. Fascinating.

EAU: 200 million people in the US who are estimated to get their water from optimally fluoridated community water fluoridation sources at 0.7 parts per million,

EW: I mean, this just to me speaks even further to that. The, the point of the anti fluoridation movement is not to actually like protect health, it's just to deregulate and be anti expert because I really, I really do want to know whether these states that are introducing these anti fluoride bans or these fluoride bans are doing anything in the communities that are served by naturally fluoridated water at levels that are shown to have any sort of health

EAU: Yeah. And I also want to point out a big difference that I noticed. 'cause again, I. There are so many papers on this and there are so many papers that have a very clear bent to them. Right, because I mean, even scientists, like we all have our own biases, right? Um, and, and some of them have a very clear bent. Some of them it's maybe less clear. Uh, and, and I mean in both directions, right? Like some are very clearly like pro-fluoride and some are very clearly anti fluoride and a lot are somewhere in between, but. From the scientific side and not from like the social media side or the political side or the like we, like it is a neurotoxin. It's killing us side, right? All of the papers, even the ones that are very concerned about fluoride in their water, the main concern that I took away from those is the potential effect of maternal ingestion, of high levels of fluoride or infant ingestion of high levels of fluoride, especially in the context, which I will say I had not thought about before of formula use. Like if babies are not breastfed and are fed by formula, because some formulas actually have relatively higher levels of fluoride. So then if you are also using fluoridated water, whether naturally fluoridated or optimally fluoridated, because infants are so tiny, could you potentially be getting too much in those tiny humans? But even on those points, there has been very mixed results from even like long-term studies. There was a paper from 2019 in JAMA Pediatrics that got a lot of

press and it seems was very controversial. Um, that showed a, for looking specifically at maternal ingestion of fluoridated water in Canada where they optimally fluoridated their water. They showed a reduction in IQ in those babies born to people who are drinking fluoridated water, but only in boys. And that was not true in girls and it was not true if you looked at all babies. So that was a little bit like we don't understand how that could be. And then another analysis on, I don't know if it was the exact same cohort or, but like using that same study. 'Cause it was like this really huge study in Canada that came out a couple years later actually did not show any difference in IQ once they accounted for exposure after birth. So even kids who are drinking fluoride in their water did not have lower IQ than those who are not drinking fluoridated water. So again, the data is still a little bit messy. Like there's not a clear, there's not a clear association there at optimally fluoridated levels.

EW: Right. Okay. I, I think I'm just confused by the, those studies are like, what they're, what the conclusions are. I mean, basically It sounds like it's noisy and a

EAU: noisy and a mess and there's still not, like, there is not the conclusion that optimally fluoridated water has an impact on IQ

EW: and I think that's, that's the message that gets lost because people will just say fluoride there is a big difference between fluoride and, and optimally, like naturally fluoridated and optimally fluoridated or like managed fluoride

EAU: Manage fluoride levels and just, just to make this, drive this point home with regards to any of the other so-called neurotoxic effects, because sometimes fluoride just gets labeled as like a neurotoxin. There is not any data to back up any of the other claims. Uh, headaches, insomnia, lethargy, autism, A DHD. There's no data whatsoever that positively associates fluoride in our water with any of those other neurologic effects. Only IQ and only at levels that are higher than the World Health Organization maximum recommended level twice as high as what we see in community water fluoridation.

EW: Twice as high. Yeah.

EAU: So for me. What I, one of the main conclusions that I come to when we look at this [00:55:00] debate on fluoride is that there is always going to be a certain degree of uncertainty in science, right? We've talked about this

EW: lot it in our, yeah.

EAU: and that can sometimes feel really scary, but the nature of the scientific process and scientific inquiry is to keep asking questions, could we do this better? Can we make this safer? Can we improve on our processes? What changes do we need to make? What studies do we need to do to gather more data?

EW: I. Mean, it's why we revised the, the optimally fluoridated level to 0.7

EAU: That's exactly why

EW: eight years ago.

EAU: we revised it right. At the same time, we have to function as a society. Our governments, our regulatory bodies, they have to make best decisions that they can based on the data that we have. And that is exactly what has happened and continues to be happening. When it comes to fluoride. No one is not looking at this problem. There is so much data now that we have that at the levels of fluoride that exist in some of the naturally fluoridated areas. We need to figure out how to lower fluoride levels in those communities 'cause we could potentially be causing harm.

EW: Yeah.

EAU: And there is data that at the level of 0.7 milligrams per liter at less than 1.5, there is a significant improvement in our dental health and no adverse effects other than a slight increase in mild dental fluorosis.

EW: I mean, and some of this stuff, like, I think it's hard because, and we talked about this a little last week, we've been fluoridating water for 80

EAU: Mm-hmm.

EW: and things have we, and we've learned a lot in that time and we've made adjustments accordingly in that time. And we've been open. I, I do think, I think there's sometimes an accusation from certain individuals or people with certain agendas to say that science just barges ahead without thinking of the consequences.

EAU: And sometimes we do.

EW: Sometimes we do there. I mean, there's, this is, this podcast will kill you. We've talked about a lot of instances where that's happened,

EAU: Exactly.

EW: but I think when it comes to fluoride, like, just like you said, that the, the questions, the fact that there are still some unanswered questions is not, cannot erase the fact that we have answered many, many, many questions about fluoride and optimally fluoridated water.

EAU: Exactly. I do think it's, it's not, this is not the end of the fluoride story. There's going to be more data, more studies that keep being done, especially at like, trying to pull apart the nuances. Should we go from 0.7 to 0.5, to 0.6 to 0.65? I don't know. Can we keep doing better?

EW: And I think some of the data will come from these states that are choosing to stop Fluoridating

EAU: We already have data. You mentioned last week Erin in Calgary in Canada where they took fluoride out of the water. There was a 10 year analysis that has looked so far and has seen a slight, not like a huge, but a slight increase in dental caries there compared to Edmonton, which still has Fluor Fluoridated water. Um, there's also a few other studies that I cite that, that are looking at exactly the same thing. So in places where they've taken fluoride out of the water, what do we see? We see worse dental health. Um. The, the other thing I think that for me this really points out is like the importance of our federal regulatory bodies and how essential they are in keeping our drinking water safe. Because if we're talking about, oh my gosh, we're looking at this potentially extremely harmful chemical, and all of these effects then, and like our community water systems are actually poisoning us, first of all, we gotta look at the data. So we need some scientists to actually look at the data and explore all of this nuance, which they've done. And then we need our regulatory agencies to be able to identify what the limits should be and enforce those limits. So who is going to fund that

EW: right. These jobs should exist And some of them no

EAU: Exactly. They're already being taken away.

EW: Right. What pathogens are in milk. The like what? Bird flu in milk, you know? It's just, there's so much.

EAU: That's the thing that's, so I think frustrating about the discourse surrounding fluoride right now is it's like, we'll take this out of our water. When it's like, what? Then who, what? Like, first of all, who is going to do that?

Second of all, who, who is going to enforce this? What about all the places that are already have it there? Like the politics of it are just so different from what the science shows right now.

EW: Oh, and I think that's the whole point, right? Fluoride is, is a tool to, you know. again, deregulate and privatize and, um, change who the experts

EAU: I know. Well, if you wanna become an expert on this, let me tell you where to read. Okay.

EW: Yes.

EAU: Uh, I already mentioned there was a great nature use disease primaries paper, just about, uh, dental caries. It was called dental caries from 2017. [01:00:00] A couple of other great papers that I had on the mechanism of action of fluoride. Actually, Erin, did you read this one from the Journal of Dental Research from 2019. It was called Fluoride Mode of Action once there was an Observant Dentist.

EW: Uh, no I

EAU: It was really fun. It was like quite historical, but it was really, really fun. Um, then when we get into the, you know, the meat of what people want the paper from 2025. From JAMA Pediatrics was by Taylor at all fluoride exposure and Children's IQ scores. A systematic review and meta-analysis. The one from a couple years earlier that looked at more relevant fluoride levels was by Kumar Etal in the journal Public Health that was titled, association Between Low Fluoride Exposure and Children's Intelligence, A Meta-Analysis Relevant to Community Water Fluoridation. There was another one I actually loved. Sorry, I'm giving shout outs longer than I usually do, but this one was super great from 2024 by Teer Etal. I'm sorry if I'm pronouncing that wrong. In critical reviews and toxicology, this paper looked not just at iq, but this one looked at. Every claim that people have made about fluoride. What is the evidence epidemiologically? What is the toxicological evidence? Um, what is the evidence in animals in vitro? And it came up with this really comprehensive table to look at all of these. And so that is a really great paper. You can check out the list of sources from this episode on every single one of our episodes on our website. This podcast will kill you.com. There's so many more.

EW: so many more. Thank you again so much. to Dr. Santore for sharing that story with

EAU: Thank you so

EW: you so

EAU: We really do thank you also to Blood Mobile for providing the music for this episode and all of our episodes.

EW: all of 'em. Thank you to Tom and Leanna and Pete, and Brent, and Jess and everyone at Exactly right, who helps this to happen. Helps this to happen. Helps us make this happen. Yeah, Here we go. We'll go with that.

EAU: And thank you to all of you for listening, for watching, for joining us on this journey. We're done with fluoride for now.

EW: for now, but we're not done with teeth

EAU: No.

EW: or gums or flossing or whatever. Anyway, thank you also to our wonderful patrons. We appreciate your support so very much.

EAU: Thank you.

EW: Well, until next time. Brush your teeth

EAU: You filthy animals

EW: and wash your hands.

EAU: both.