

# Yale CANCER CENTER *answers*

WNPR Connecticut Public Radio



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## **Hydraulic Fracturing and Health Risks**

### **Guest Expert: Dr. Nicole Deziel**

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*Welcome to Yale Cancer Center Answers with your hosts doctors Anees Chagpar, Susan Higgins and Steven Gore. Dr. Chagpar is Associate Professor of Surgical Oncology and Director of the Breast Center at Smilow Cancer Hospital. Dr. Higgins is Professor of Therapeutic Radiology and of Obstetrics, Gynecology and Reproductive Sciences and Dr. Gore is Director of Hematological Malignancies at Smilow and an expert on Myelodysplastic Syndromes. Yale Cancer Center Answers features weekly conversations about the research diagnosis and treatment of cancer and if you would like to join the conversation, you could submit questions and comments to [canceranswers@yale.edu](mailto:canceranswers@yale.edu) or you can leave a voicemail message at 888-234-4YCC. This week it is a conversation about environmental health risks with Dr. Nicole Deziel. Dr. Deziel is Assistant Professor of Epidemiology and Environmental Health at Yale School of Public Health. Here is Dr. Susan Higgins.*

Higgins I thought we would start by having you tell us a little bit about yourself and how you got into the field of epidemiology.

Deziel I grew up on Long Island, New York just across the Sound here and I grew up in the 70s, 80s and 90s and there were a lot of stories back then in the popular press about cancer clusters, particularly breast cancer, and many people wondered whether this was due to pesticides or the above ground power lines or some industrial pollution like polychlorinated biphenyls or PCBs, but there really was not a lot of information and there was a lot of uncertainty about these types of exposures and the role they may play in terms of cancer risk and that was an early motivator for me to get into this field of environmental health.

Higgins People come to me all the time as a clinician and this is a great source of angst and anxiety for them, that there are some things they cannot help, they are out there in the environment and are causing their breast cancer, or their uterine cancer, and we need people like you to sort these things out with the real science.

Deziel Some things are a little bit beyond an individual's control, but science can help and form regulation and policies that can reduce people's exposures. You cannot control the air that you breathe outside, but I also study a number of things that people do have within their control, things that might be inside their homes.

Higgins You focus a lot on the environment and just to define that, I think people think of environment as the air, air pollution and things like that, but when we think about environmental carcinogens or deleterious agents to our health, we do not think about food. Pesticides are something I think people are very aware of, but food is one of the things we really never considered, up until recently, a carcinogen or a damaging agent, especially when we think about the things we eat every day like red meat, and this just came into the news.

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Deziel You are right, in the field of environmental health, there is a movement to define the environment much more broadly, so really anything that is external to a human being, it could include the air, the water, the dust in your home, those are the traditional pollutants, but also things like what you eat, not necessarily the nutrients say in the food, but there are a number of other chemicals that are formed either by the way the food is processed, the way we cook it, the way it is packaged, all of those would certainly fall under environmental exposures, so you are absolutely right, just this week, IARC (International Agency for Research on Cancer) classified processed meats as a known human carcinogen and that is the strongest category that they have available, and then red meat was classified as a probable human carcinogen and this is in part based on epidemiologic studies looking at people who consume higher amounts of these types of foods and their risk of various cancers. For example, in some of my early work, I actually looked at what is it about the meat that might increase the risk of cancer and we like to think of epidemiology as being detective work and one of the most important and most challenging aspects of this detective work is trying to get high quality accurate measurements of what people are exposed to, so if you ask somebody how much meat do you eat in a year, it is a very difficult question to answer, but if you can ask much more specific questions perhaps, and ask how many hamburgers do you have per week and how are they cooked and try to increase the specificity of the questions, you can improve the accuracy of your questions and the National Cancer Institute has done tremendous amounts of work in this area and in some of my research I compared what people said they ate to actual measurements of some of the metabolites of these meat carcinogens in their urine, so that is really an objective measure of what people are exposed to so we can compare that to people's self-reported information about their diet and that is a nice example of the type of work I do, comparing different methods, different tools we have to uncover these clues about exposures and trying to figure out what is the best measure that we can use in an epidemiologic study.

Higgins I like this concept of the detective, and I think people are not aware of all the tools that an epidemiologist has, you have questionnaires, and can you round that out and tell us about all the different ways that you have to know the right question to ask, and then you also have to be able to tease out these things that we call confounding variables and so maybe you could talk about the detective work part of it?

Deziel I would love to, I really have more of an expertise in exposure science and that is this detective work where you are looking at exposure to different chemicals, so we have many tools in our tool box to look for these types of clues, as you said, we can ask people about their habits, about where they spend their time, where they live; however, some chemicals, some peoples exposures are not knowable, for example, another point that I study are a class of pollutants or the flame retardant chemicals that are added to our televisions and our couch cushions and upholstery and if I asked you, do you have flame retardants in your couch, you would not know, the average person

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does not know, it is not on the label, it is not knowable to a person, so in that case, the questionnaire is not going to work, so we have some other tools that we can use, we can measure chemicals in blood and urine as the example I gave previously looking at the meat mutagens, so these flame retardants we can measure in people's blood and urine. We can also take samples in people's homes, and I have done some work where we collect peoples' vacuum cleaner bags because the dust in your carpet actually reflects longer term exposure to a variety of chemicals that are in your home that you might track in that drift in from the outside, so that is another objective measure of exposure and then the last tool that we can use as exposure scientists, environmental epidemiologists, is modeling, so if we know you live near a factory or hydraulic fracturing wells, we can map how close you are to different pollutants, we can try to estimate or model dispersion of different pollutants to your home.

Higgins I am glad that you brought up hydraulic fracturing. I hear this topic bounced around in the media and it is a little bit of a mystery to some people. What is fracking and hydraulic fracturing and why is it important to us as individuals?

Deziel Hydraulic fracturing is often used to describe a broader process of extracting oil and natural gas, fossil fuels, from resources that were previously unavailable to us, so for example, now oil and gas companies have this incredible technology where they can drill a mile or two below ground and then turn the drill so it is drilling horizontally into a rock that is like concrete and drill for a mile or two into this rock and then they pump water and chemicals under high pressure into the rock and it breaks open the rock and then that allows natural gas to flow up the well and it can be used for fuel for energy, so the actual term fracking or hydraulic fracturing really refers to using water to break open the rock, but we think of it now and many people understand it or use this term to not only capture that one step of breaking the rock, but all the construction that is involved in drilling a well when you have diesel equipment running 24/7 and it is noisy and you have all the people and workers moving into an area doing this drilling work that is actually fracking the production of the gas, the distribution of the gas, so it is a large process and it is expanding very rapidly in this country and we actually know very little about the potential health risks.

Higgins What do we think might be some of the most potent and most harmful agents that come from that process?

Deziel From this process, there could be water contamination, I mentioned that millions of gallons of water and chemicals are involved in this process. There could be air pollutants from the construction and drilling of the well. There is this influx of workers, there is noise, there is stress, so there are many potential sources. In terms of cancer, there is a hypothesis that when you have an influx of workers into a community, they call it population mixing, and they are bringing their

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germs and their infections to a somewhat isolated rural population that may not have been exposed to these and there is a hypothesis that this could affect the immune system and lead to childhood leukemia, for example. Also in terms of cancer specifically, there is exposure to things like benzene which is a known leukemogen, particulate matter, diesel exhaust, metals like lead and arsenic, many known or suspected carcinogenic chemicals could be in the air or the water as well.

Higgins That one issue that you just mentioned is kind of fascinating, that you have a population of people, maybe indigenous to an area, living there a long time and then here comes the big fracking company into their backyard. It actually brings, what sounds like what we as clinicians would call antigens and different diseases into the community that maybe they were not exposed before.

Deziel Yeah that is a very interesting hypothesis that originated in England. There are a lot of studies looking at building a nuclear power plant, for example, and having all these workers come in, so I think there is a lot more to understand about that as one of the potential risk factors for cancer but it is very intriguing.

Higgins In terms of the big picture, you are like the detective, you are looking at our environment and trying to sort out all of these things that are kind of true or false, it is a carcinogen or maybe it is not, but some of the things you are looking at are economy driven right, our world is constantly changing because of, it sounds like one of the things here, is energy right, fracking is part of it and it makes me think that maybe a lot of your findings, and findings of other epidemiologists, are going to be able to drive the policy makers to do things that protect us, I mean heavy metals have been out there for a long time and I think we know about those, but radon is another thing that I think epidemiologists figured out. What do you think is on the horizon in terms of other sort of public policy issues that are up and coming? Are there things that we may have never thought about but are carcinogens that people like you are looking into, or exposures, etc.?

Deziel I really strive to do policy relevant work, and I hope that I am achieving that, and I think you are right that energy and burning of fossil fuels produces a lot of pollutants and has a lot of implications for climate change and with the change in climate, we may see changing exposures and also just the way our economy works, we identify certain pollutants to be toxic or carcinogenic, for example the flame retardants that I mentioned, they are an example of the class that I have been studying, polybrominated diphenyl ether flame retardants, and we know that those are carcinogenic or potentially carcinogenic or toxic and so they are being replaced by

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alternatives. We are constantly seeing substitute products for things we know are toxic so it is a constant revolving door of chemicals that we as scientists have to try to keep up with as we move ahead.

Higgins That is great, thanks so much. We are going to take a short break for a medical minute. Please stay tuned to learn more information about environmental health risks with our guest, Dr. Nicole Deziel.

*Medical Minute*

*Smoking can be a very strong habit that involves the potent drug nicotine and there are many obstacles to face when quitting smoking, but smoking cessation is a very important lifestyle change especially for patients undergoing cancer treatment. Quitting smoking has been shown to positively impact response to treatments and decrease the likelihood that patients will develop second malignancies. Smoking cessation programs are currently being offered at federally designated comprehensive cancer centers such as Yale Cancer Center and at Smilow Cancer Hospital at Yale-New Haven. The smoking cessation service at Smilow operates on the principles of the US Public Health Service clinical practice guidelines. All treatment components are evidence based and therefore all patients are treated with FDA approved first line medications and smoking cessation counseling. This has been a medical minute brought to you as a public service by Yale Cancer Center and Smilow Cancer Hospital at Yale-New Haven. For more information, go to [yalecancercenter.org](http://yalecancercenter.org). You are listening to WNPR, Connecticut's Public Media Source for news and ideas.*

Higgins Welcome back to Yale Cancer Center Answers. This is Dr. Susan Higgins along with Dr. Nicole Deziel and we are talking about environmental health risks and cancer. In the last half, we discussed briefly a few of your research interests and one that I find really interesting is the flame retardants because it seems like flame retardants are actually something that we are not even aware of, they are in our environment, but it sounds like they are in multiple things in our environment. Could you tell us about the types of places we might find flame retardants where we do not even expect them?

Deziel Yes, they are ubiquitous in our environment, and these are chemicals that are added to consumer products to slow the spread of fire, so it does have a purported public health benefit, although the actual beneficial effect on reducing fire injuries and fire death has certainly been debated. These chemicals are found in our carpets and polyurethane foam and cushions, so that includes couch cushions, automobile furniture, baby seats, car seats, curtains, carpets, TVs, computers, a variety of different electronic devices and these also may be not only in your home but as I said, in the car, in the office, so they really are everywhere.

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Higgins What is the biology of the exposure, is it like asbestos where there are mini particles that we inhale, is that how it may be harmful to us?

Deziel This is a really interesting question and the reason why these chemicals even got on our radar was in Sweden they had the foresight to have a breast milk bank and they stored breast milk samples for many years and they measured these chemicals in breast milk and found exponential increase in these chemicals and that was before we even understood what they did or where they were coming from, so this has shined a light on these PVDE or polybrominated diphenyl ether retardants and spurred a real active area of research, so it is only in the last few years that we have been able to figure out that these chemicals are not bound in the televisions and the cushions, they migrate out after use of these items and they are in our dust, so we can be exposed to them via dermal contact from sitting on the couch but also just hand to mouth activity, just in touching surfaces and having some hand to mouth activity in the home, resuspension of the dust and particles and breathing them in inside the home and also we do see these chemicals because they are very fat soluble which is why they were in high levels in breast milk, so they can also be in food and in the food chain they can accumulate, particularly in animal products that are high in fat content, but it seems that the main root of exposure is through the dust inside the home.

Higgins This is something that when you are home, you are not thinking about these things but we are always being exposed to things in the environment that we basically have to now sort out how important this is and it sounds like this is part of your new grant from the American Cancer Society. Could you talk about the grant and where you are going to go with that and how you do that research specifically?

Deziel I am so happy that this research started, first with the pilot grant from Yale Cancer Center and the American Cancer Society, and I am so appreciative to have that start and that led me to get a larger grant from the American Cancer Society, which is a mentored grant so I am working with other colleagues who have appeared on this show like Yawei Zhang, Melinda Irwin and Ted Holford, and one of my goals in this grant is to look at these polybrominated diphenyl ether flame retardants and risk of thyroid cancer. One thing that is interesting about these chemicals is they actually look a lot like one of our thyroid hormones, so it confuses the body and the body sees these chemicals and may mistake it for our thyroid hormone and that can trigger a whole cascade of events that may potentially lead to thyroid cancer and thyroid cancer is rapidly increasing and the increased incidence in thyroid cancer also parallels increased use of these particular flame retardant chemicals so I am very eager to pursue this to see if there is an association. One issue that I will be dealing with in this grant is trying to sort out which of the flame retardants and how these flame retardants fit into other exposures, so these flame retardants are part of a group of

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persistent organic pollutants. They look a lot like DDT. There are other pesticides that are somewhat similar in structure, the polychlorinated biphenyls which is another pollutant I had mentioned earlier that also fits in this category, so in this analysis, we are actually going to be measuring more than 50 of these persistent pollutants in blood samples of people who have thyroid cancer and people who are healthy and we are going to compare the exposure levels of these pollutants in the cases and the controls and we are going to apply some really novel statistical techniques to try to sort out which flame retardant, because there are many different flame retardants, and how they fit in with also these other types of pollutants, so we really want to sort out which one is the bad actor, traditional epidemiology and environmental epidemiology has looked at one chemical at a time or maybe one small group of chemicals at a time and we may be missing important combinations where 2 chemicals may act synergistically or antagonistically so these types of statistical tools should really shed some light on this and hopefully allow us to tease out which is the most important ideologization.

Higgins Because it becomes, as you said, the history has been asking some simple questions, is radon exposure in your home related to lung cancer and they look at that one thing and one disease but you are talking about a much more sophisticated process where there are multiple agents and I imagine you also have to figure out the weight of each agent and use statistics to sort out how important they are, so that is one of the big tools in your tool kit, statistics, I would imagine you need a robust software, a whole group of statisticians working on this, correct?

Deziel Exactly yes, I will definitely be collaborating with some really top notch statisticians to help implement these really sophisticated approaches, yes.

Higgins Which makes most of us from medical school quake thinking back to the stats that we did which were so simple, but still a little intimidating, so I really admire that you have this group of people who just put their energies into something that is actually not very straight forward, the modeling, coming up with these statistical tools is an innovative area I think that people in terms of health research do not appreciate, there is a whole group of people and that is all they do, figuring out how to find the answer to the question and ask the right questions with math basically, right?

Deziel Yes, I am so grateful that we have them also because it is a little intimidating to look at some of these new techniques, bastion models and weighted quantile, some regressions, all of these things were I can understand the purpose and work with them and they can really help me implement these really novel and complicated tools.

Higgins One of the things that we discussed before and this has been in the news in the past but it is still a persistent problem, and this is economy driven, growing food and exporting food and using

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pesticides is a very big issue and I know there are different international rules about pesticides and we have certainly had some imports and export issues with pesticides, maybe you could talk about your work with pesticides and how that relates to overall health for people in the US?

Deziel Getting back to the exposure, I always start with an environmental problem, we can be exposed to pesticides from our use in and around our home, for spraying, for roaches or ants or termites, so that is one potential source or pathway. We can be exposed if we live in rural areas and we live near farmlands where pesticides are applied and pesticides do not stay where they are applied, they drift either through winds, they are carried on particles into homes, far from where they were applied and then there are also some people that work with pesticides, so there has been a lot of work done with the agricultural health study which is a joint effort by the National Cancer Institute, the Environmental Protection Agency, and the National Institute for Environmental Health Sciences to look at farmers who in general tend to be quite healthy, they do not have high rates of smoking, they are doing lots of physical labor, yet they do have higher rates of certain types of cancer, so maybe it is the pesticides, also we have the exposure from the food supply as you mentioned and we have been talking about things in the news and just a few weeks ago, the International Agency for Research on Cancer classified glyphosate, which is very popular herbicide used in the product roundup, as a probable human carcinogen.

Higgins: This is the stuff you spray in your driveway when you have weeds, right?

Deziel Right, and it is also used widely agriculturally on corn and soybeans, for example, so there are many ways we can be exposed to these various pesticides and also pesticides are really a very heterogeneous group, they comprise lots of different chemical structures, have different properties, behave differently. By nature, they are designed to be toxic, they are designed to kill things, either insects or weeds, but that does not necessarily mean they cause cancer, so it is important to do the work to see if they actually are associated with increased risks of cancer.

Higgins But there are other things, if I am remembering correctly, some of the pesticides are neurotoxins too right?

Deziel Yes.

Higgins It is not just cancer, we have heard in the news recently that these happen mostly offshore that people are exposed and are having very poor outcomes after exposure to these neurotoxic pesticides right? There can be a fatal exposure right?

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Deziel Absolutely, there could be high levels, you could die of coma, death from misuse, mishandling of these chemicals because they are designed to be neurotoxic to kill insects, for example, but yes there has been a lot of research looking at children and impacts on IQ and cognitive development as well as cancer. In some of my research, I have worked on studies looking at pesticide exposure and childhood leukemia, for example, with the National Cancer Institute and there again I have this exposure bent, how can we best measure exposure, so there are many studies and several meta-analyses which summarize research on a given topic.

Higgins Maybe we could just go back to the meta-analysis, probably our listeners are not all familiar with what a meta-analysis is, could you talk about how this is a big data topic and explain that?

Deziel Yes, meta- analysis is a statistical tool that is used to pool and combine and integrate many studies on a very specific research question, so there have been several recent meta-analyses that have looked at pesticide exposure and childhood leukemia and found a clear association between the exposure and the disease. Now most of these studies rely on parental self-report of pesticide use, again asking people questions about the types of pesticides or if they use pesticides in and around the home, so I recently published a study looking at how well does that correlate, this parental reporting of pesticide use, with what is actually measured in the dust in people's homes and actually we found very good associations between what parents said they use and what we could measure in the dust and 2 important aspects from the study we found are that if you ask people, do you use glyphosate, people are not going to be able to report that, but if you can ask very specific questions, did you treat for weeds or did you treat your pet for fleas or ticks, those types of specific questions were associated with the types of pesticides that would be present in those types of products.

*Dr. Nicole Deziel is an Assistant Professor of Epidemiology and Environmental Health at Yale School of Public Health. We invite you to share your questions and comments, you can send them to [canceranswers@yale.edu](mailto:canceranswers@yale.edu) or you can leave a voicemail message at 888-234-4YCC and as an additional resource, archived programs are available in both audio and written form at [yalecancercenter.org](http://yalecancercenter.org). I am Bruce Barber hoping you will join us again next Sunday evening at 6:00 for another edition of Yale Cancer Center Answers here on WNPR, Connecticut's Public Media Source for news and ideas.*