Rounds we have two speakers
today from male to wonderful
speakers first or Hegel on my own,
I've known Jorge since before he arrived at Yale.
He's now the Lucille P Marquis,
professor, microbial pathogenesis
and chair of the Department.
In his lab studies bacterial infections,
he's probably best known for his
discovery and characterization of
the Type 3 secretion apparatus,
which is this microscopic needle that injects proteins into cells. A fantastic story, and in recognition of this work, he’s received numerous awards and been elected to the National Academy of Sciences, but more recently he’s got interested in the Association between cancer and bacteria, and mechanistically, how does that work, and he’s shown, for example, that some bacterial toxins can induce DNA damage. And therefore are potential carcinogens. And so today we’ll hear about this very exciting work.
So Jorge, the floor is yours.

Thanks Dan, and yeah as then.

Imply microbes and cancer are a lot more intertwined than many would think.

If we start with the obvious that 20% of cancers are caused by microbial infections.

The you know of all these examples of gastric cancer and helicobacter anogenital, cancer and HPV, and so on and so forth.

So these are the known causes of microbial causes of cancer.

That amount to that 20%.
But by all accounts this is probably rose underestimate in terms of the influence in the etiology of cancer of microbes. But Microsoft, either toying with cancer in many other ways. For example, the study of microbial pathogens really have provided fundamental knowledge for the understanding of cancer. You, of course, are aware that Uncle genes really were discovered through the study of a chicken ritualize. And today the study of host pathogen
interactions have provided insight into cancer that are extremely important for the fundamental knowledge. Of course, infectious diseases as an entity are really a significant challenge in the context of cancer patients. Many of the drugs that we administer to treat cancer or course have immunosuppressive power an and that increases the susceptibility of patients to infectious diseases and imposes it challenge in many. In many therapeutic set settings. And of course, the elephant in the room.
The resident microbiome, which in the last you know five years or so, is quickly emerging as a major factor, both in terms of cancer etiology and cancer treatment. So what I’m trying to tell you here is something that should be obvious and that this is an extremely important aspect of cancer biology and quite frankly, one of the most exciting times to be involved in this research space. So the that’s perhaps the reason why maybe some of us were a bit disappointed when the cancer
microbiology piece of the Cancer Center was interrupted. In fact, when I was invited to give this talk, I was invited as a member of the Cancer Microbiology Group, which now doesn’t exist. And although I completely understand why the leadership of the Cancer Center to please this step, they had to tend to an impending Cancer Center grant. That obviously didn’t take many of these things, and it is clear that you know cancer, microbiology or microbes really are
not the this the so called cancer establishment from which reviewers will be drawn to review the Cancer Center grant. I’m not really friendly to the concept of Micros, Ann and cancer. For for whatever reason, and even other considerations, other currencies that are used in the evaluation of these grants, such As for example in CI grants. You know, people work with my girls that that don’t score high on that because it will be a fundraising malpractice. If you can send your grant when
I need to send it to NCI, which is much less generous and certainly less friendly to these courses. So I although I totally understand these, I think it is an opportunity loss for leadership, particularly with the really the history of deal with the tremendous leadership. People like Dundee Moniot or Charles Miller. In the space of Uncle Virus, for example, there is a lot of history here on this space. But life is life and the cancer establishment is the cancer establishment. This is the same establishment that 10 years ago or 20 years ago, worse naughty related to cancer immunology.
It with people like blow it all the late, allowing all that was advocating for it. And he was really honestly looked down. I was a close collaborator, the law and he always complained. Of course he was shielded by the Ludwig Cancer Center. He didn’t have to worry about, but anyway, I think he said more of a loss opportunity. But I totally understand why this decision was made, so enough venting enough Priscilla Teising. Let’s get back to business here and in order to put in context a little bit,
what I will tell you briefly is is to consider the general mechanisms by which microbes induce cancer and and there are two types of mechanisms. If you will. The direct Uncle Genesis and that is obvious when a virus is introduces an Uncle gene itself. This is of course. The mechanisms behind HPB or a BB, for example. Or when it when they integration event itself access and origin, because obviously the viruses integrate upstream of some gene that can drive sort of proliferation and growth. That’s that’s direct on Go Genesis,
but arguably more common is the indirect organ Genesis, and this takes several forms. For example the form in which viruses in a cost, immunosuppression and immunosuppression activates for example. Other two more viruses. In the case of Kaposi sarcoma, is an HIV infection. It comes to mind or when viruses triggers chromosome instability or translocation that eventually die. Of course, leads to cancer and other
aspects of the Director Genesis

more related to what I'm being,

I'm going to be telling you today is,

for example, chronic inflammation,

which is very well established to

be linked to to Uncle Genesis.

The production of proinflammatory

cytokines that have growth promoting

abilities combined with oxygen radicals.

They have a mutation or mutagenesis ability

leads to setting the stage for Franco,

Genesis is the case,

for example with Helicobacter

pylori and gastric cancer,

and in addition something that has been

emerging over the last few years and
that we sort of Pioneer in this area

is the fact that certain organisms really produce direct Gina toxins that will drive the oncogenic event.

So I say alluded these last two are the ones more relevant to bacteria, which is the type of microbes that we study in the lab.

So bacterial is in this context bacterial colonization leads to both inflammation and genotoxin production and exposures of tissues to genotoxin and therefore predisposing those tissues to cancel.

What I'm gonna be telling you today
00:08:23.121 --> 00:08:26.088 is the paradigm of two organisms that
NOTE Confidence: 0.79306287
00:08:26.088 --> 00:08:29.354 we study in the lab. Both of them.
NOTE Confidence: 0.79306287
00:08:29.354 --> 00:08:31.066 These organisms are salmonella
NOTE Confidence: 0.79306287
00:08:31.066 --> 00:08:32.350 and campylobacter jejuni.
NOTE Confidence: 0.79306287
00:08:32.350 --> 00:08:34.912 Both of them have been very
NOTE Confidence: 0.79306287
00:08:34.912 --> 00:08:35.766 strongly epidemiological.
NOTE Confidence: 0.79306287
00:08:35.770 --> 00:08:37.940 He associated with the development
NOTE Confidence: 0.79306287
00:08:37.940 --> 00:08:39.676 of cancer Campylobacter jejuni
NOTE Confidence: 0.79306287
00:08:39.676 --> 00:08:41.770 associated with an intestinal lymphoma,
NOTE Confidence: 0.79306287
00:08:41.770 --> 00:08:43.430 and while Salmonella Typhi,
NOTE Confidence: 0.79306287
00:08:43.430 --> 00:08:46.648 one of these family that we study in
NOTE Confidence: 0.79306287
00:08:46.648 --> 00:08:49.240 the lab is really a major cause of
NOTE Confidence: 0.79306287
00:08:49.323 --> 00:08:51.435 Gallbladder cancer and Gallbladder
NOTE Confidence: 0.79306287
00:08:51.435 --> 00:08:55.085 cancer in endemic areas is actually one
NOTE Confidence: 0.79306287
00:08:55.085 --> 00:08:58.410 of the main cancers that affect those.
NOTE Confidence: 0.79306287
00:08:58.410 --> 00:09:01.620 Individuals and it infections with
Salmonella Typhi and associated with a 204 risk of hip, hepatobiliary carcinoma and Gallbladder cancer, so these are important causes of cancer which incidentally are not in that 20% statistic that I told you about. Now, in the case of Campylobacter, what we discovered that was sort of central to understand how these organisms linked to oncogenesis is a characterization of a toxin that we did almost two decades ago.
actually scary more than two decades ago?

That he said toxin that caught our attention because of what you see here in in.

In these images, these are cells that are intoxicated.

You see them very much expanded with a large nuclei in comparison to control cell at the same excuse me Jorge,

your your slide is not. It did not advance.

Papa you mean?

I mean what they have you on the 1st slide?

Oh gosh, that’s that’s not good.

That can you see them this way now?

Yeah, that I can see those OK when

I when I do it that way because OK,
NOTE Confidence: 0.820451730769231
00:10:17.560 --> 00:10:18.580 yeah unfortunately because
NOTE Confidence: 0.820451730769231
00:10:18.580 --> 00:10:20.620 whatever it would have been easier.
NOTE Confidence: 0.820451730769231
00:10:20.620 --> 00:10:23.000 But thank you for letting me know.
NOTE Confidence: 0.820451730769231
00:10:23.000 --> 00:10:25.720 OK so anyway, so here it is the.
NOTE Confidence: 0.76506776
00:10:28.960 --> 00:10:31.402 OK, so this image is showing
NOTE Confidence: 0.76506776
00:10:31.402 --> 00:10:34.754 you the the cells that have been
NOTE Confidence: 0.76506776
00:10:34.754 --> 00:10:36.930 intoxicated with this toxin,
NOTE Confidence: 0.76506776
00:10:36.930 --> 00:10:39.194 showing this unusual morphology.
NOTE Confidence: 0.76506776
00:10:39.194 --> 00:10:42.024 In comparison we control cell
NOTE Confidence: 0.76506776
00:10:42.024 --> 00:10:45.352 and the reason these cells have
NOTE Confidence: 0.76506776
00:10:45.352 --> 00:10:47.488 that morphology is becaused.
NOTE Confidence: 0.76506776
00:10:47.490 --> 00:10:50.698 The cells are stuck on the G2M phase
NOTE Confidence: 0.76506776
00:10:50.698 --> 00:10:53.828 of the cell cycle and we found
NOTE Confidence: 0.76506776
00:10:53.828 --> 00:10:57.141 that the reason for that is that
NOTE Confidence: 0.76506776
00:10:57.141 --> 00:11:00.075 this toxin that we had discovered.
NOTE Confidence: 0.76506776
It has a genotoxicity DNA damage in capacity, those this is a toxin typical toxin of we call AB. Toxins have two types of parts. If you will the be part, which is what targets the payload to a particular cell and the payload part. The nucleus is an endonuclease in the sense that primary amino acid sequence would not overtly tell you that this is a new case. actually an unusual in the nucleus in the sense that primary amino acid sequence would not overtly tell you that this is a new case. But when you look at the atomic structure, you can make out the catalytic side. So so this is a typical case of genotoxin that is responsible for for
driving the day on today.

Cancer development and in fact just recently, this has been formally demonstrated in an animal model that this toxin is responsible for Campylobacter jejuni's ability to promote cancer so.

It's kind of awkward to have to advise it like this, but I will go ahead. So the second example is Salmonella Typhi and I need to tell you that the basic about something that I think people things in context again and that is that someone had typhus and exclusive pathogen of humans. It causes typhoid fever.
One of those historical diseases if you will, but important for Genesis is the fact that those that survived the disease, many of them go on to persistently harbored the Organism. Within the Gallbladder and that is where the rubber meets the road and that is the reason why those individuals that are harboring salmonella typing in the areas are prone to develop Gallbladder cancer. And in the case of Salmonella the paradigm is slightly different than the paradigm in Campylobacter jejuni. But it shares it remarkably, is shares more than what would expect.
You need to think in terms of evolution. That Campylobacter and Salmonella are they. Couldn’t be more far apart. One is an epsilon bacteria, the other is a gammaproteobacteria. It’s like absolutely no evolutionary connection and yet what is remarkable is that we discover a toxin in Salmonella typhi that we call typhoid toxin. That also has the ability to induce DNA damage, as shown here in this image, and when we characterize this toxin, we were surprised to see that the active subunit of this toxin.
was virtually identical,
NOTE Confidence: 0.8201903
that the active subunit of the
NOTE Confidence: 0.8201903
completely unrelated toxin Curry
NOTE Confidence: 0.8201903
by camping of active June.
NOTE Confidence: 0.8201903
So this is really a remarkable
NOTE Confidence: 0.8201903
piece of evolution.
NOTE Confidence: 0.8201903
This is one of those head turning
NOTE Confidence: 0.8201903
toxins that actually evolution put it
NOTE Confidence: 0.8201903
together by fusing two toxins, one.
NOTE Confidence: 0.8201903
That some of you may be familiar,
NOTE Confidence: 0.8201903
it called pertussis toxin,
NOTE Confidence: 0.8201903
is what makes you a what is central for
NOTE Confidence: 0.8201903
the pathogenesis of whooping cough.
NOTE Confidence: 0.8201903
And then these other talks in that
NOTE Confidence: 0.8201903
I described earlier.
NOTE Confidence: 0.8201903
They cite a little distending toxin,
so this lower part of the talks in comes from pertussis toxin,
and this upper Paradox income from side a little extended talks,
so evolution hook them together to make this head turning toxin that Salmonella typhi encodes, and that it is responsible for the genotoxicity of these organisms. And easy sent unusual toxin in many different ways that I don’t have time to go into, but one of the remarkable ways in which this toxin is unique is that it is other patient to the human host.
And what do I mean by that?
Well, the receptor for these talks, you know the receptors.
I should say we discovered two proteins, part of policing,
one in epithelial cells and CD 45 in.
In immune cells, but what is important here is
what does the toxin see on this block of proteins and
the glycan power and we through like Andres and other types of studies for
to address these kinds of questions
we discovered that what Typhoid toxin likes if you will is glycans
terminated in the sitting room.
We know that many Kacian hooked to galactose and to glucose or setting glucosamine in this particular fashion. And why is this relevant? Well, this is important because you may not know these or many of you may be that we humans are actually rather unusual mammals in many ways, and one of the ways in which terribly unusual is in our glycosylation pattern. All our sciullo glycans are terminated in a city neuraminic acid, but all other mammals in fact, like answer, terminated in Blakely, neuraminic acid.
00:15:54.730 --> 00:15:57.190 and the reason is that the
NOTE Confidence: 0.76375777
00:15:57.190 --> 00:15:59.510 enzyme that is responsible for.
NOTE Confidence: 0.76375777
00:15:59.510 --> 00:16:02.000 Can you see this slide and?
NOTE Confidence: 0.76375777
00:16:02.000 --> 00:16:02.371 Maybe.
NOTE Confidence: 0.76375777
00:16:02.371 --> 00:16:04.597 Well, whatever I continuously the inside
NOTE Confidence: 0.76375777
00:16:04.597 --> 00:16:07.038 that is responsible for putting these acts.
NOTE Confidence: 0.76375777
00:16:07.040 --> 00:16:09.200 Oxygen here is mutated in humans.
NOTE Confidence: 0.76375777
00:16:09.200 --> 00:16:11.482 We have a pseudogene there and therefore
NOTE Confidence: 0.76375777
00:16:11.482 --> 00:16:14.692 we are unique in that fashion and typhoid
NOTE Confidence: 0.76375777
00:16:14.692 --> 00:16:16.428 toxin combined likens exclusively
NOTE Confidence: 0.76375777
00:16:16.428 --> 00:16:18.197 terminated in a city in America.
NOTE Confidence: 0.76375777
00:16:18.200 --> 00:16:19.187 And in fact,
NOTE Confidence: 0.76375777
00:16:19.187 --> 00:16:21.490 if you just change one oxidant in
NOTE Confidence: 0.76375777
00:16:21.562 --> 00:16:23.836 any of these glycans that Typhoid
NOTE Confidence: 0.76375777
00:16:23.836 --> 00:16:26.138 toxin likes and you already meaning
NOTE Confidence: 0.76375777
00:16:26.138 --> 00:16:28.994 in an array make like an array,
typhoid toxin does not bind. It also has the ability to distinguish. Just one Atom of oxygen.

Remarkable piece of evolution that makes it able to target human cells and have that oncogenic effect. But in addition to having a genotoxin somewhere, typhi is actually has the 241. In other words, is also the chronic inflammation part that plays a role in the Uncle Genesis of Salmonella Typhi. And so it’s something that I think causes chronic inflammation of the
Gallbladder and that chronic inflammation, as is well known, leads to the development of cancer or contributes to development of cancer and the paradigm here is where as I said, the production of growth. Promoting cytokines combined with or radical oxygens that Armenta Genic eventually leads to the development of cancer angiogenesis. Growth stimulation and so on and so forth. So the issue is how does salmonella trigger inflammation now on this on? On the surface, this could be a rather simple story
and you may know that we are in now with innate immune receptors famously put into the scientific space by the late Charlie Janeway here at Yale and this innate immune receptors have the capacity to recognize bacterial products. Uh, like polysaccharide peptidoglycan flagella. You name it, many bacterial products can be detected by this innate immune receptors. Them essentially coordinate an inflammatory response and that inflammatory response eventually leads to pathogen rejection and
they acquired immune response.

So this is central to the way we hosts,

But all mammals defend against microbial.

Pathogens now it turns out that then

simple to think that someone other

triggers inflammation simply

because he has plenty of LPS.

He has plenty of these product

and is the detection of the

host that drives inflammation.

In other words,

this will be like a host centric view,

but work that we have done in our

lab for the last 15 years or so has
NOTE Confidence: 0.858762
00:18:53.537 --> 00:18:55.362 completely turn around this paradigm
NOTE Confidence: 0.858762
00:18:55.362 --> 00:18:57.422 and discovered that that’s actually
NOTE Confidence: 0.858762
00:18:57.422 --> 00:18:59.734 incorrect in the case of Salmonella,
NOTE Confidence: 0.858762
00:18:59.734 --> 00:19:01.166 that salmonella really has
NOTE Confidence: 0.858762
00:19:01.166 --> 00:19:02.240 a specific adaptations.
NOTE Confidence: 0.858762
00:19:02.240 --> 00:19:04.736 Evolve by similar to trigger inflammation.
NOTE Confidence: 0.858762
00:19:04.740 --> 00:19:07.659 So this is a pathogen driven process,
NOTE Confidence: 0.858762
00:19:07.660 --> 00:19:09.750 not a host driven process,
NOTE Confidence: 0.858762
00:19:09.750 --> 00:19:12.252 and the reason is very simple
NOTE Confidence: 0.858762
00:19:12.252 --> 00:19:13.920 or not so simple.
NOTE Confidence: 0.858762
00:19:13.920 --> 00:19:16.000 Salmonella, like many other microbes,
NOTE Confidence: 0.858762
00:19:16.000 --> 00:19:18.496 when they encounter a mucosal site,
NOTE Confidence: 0.858762
00:19:18.500 --> 00:19:20.168 being an intestinal being
NOTE Confidence: 0.858762
00:19:20.168 --> 00:19:21.419 the Gallbladder mucosa,
NOTE Confidence: 0.858762
00:19:21.420 --> 00:19:24.048 they need to compete with resident
NOTE Confidence: 0.858762
32
microbiota who has a foothold on that issue and really put up a good fight. This is actually over. One of our main barriers against bacterial pathogens, particularly in this time, is the resident microbiota. The inflammatory response crosses it causes profound dysbiosis, which is essential for someone else to be able to colonize and replicate. Not only that, inflammation makes nutrients available, electron acceptors camper sourcers that otherwise would not be available in the an inflamed tissue,
and that drives the replication of the aluminum.

Population of salmon are so, so is the inflammatory response that causes even though someone else and intracellular pathogen the bulk of the bacterial replication comes from this lumenal population that is fed from the inflammatory response triggered by this in this bacteria. Here. So a nice division of Labor. Now how does someone even managed to trigger an inflammatory response? Mucosal sites which are actually is pretty difficult because mucosal
sites are subject to various stringent negative regulation of his native.

Respected receptors precisely to prevent this microbiota that in theory can also stimulate in Amy receptors to trigger an inflammatory response and for all of us to be working with IBD or Crohn’s disease. To avoid that they’re very precise mechanisms to keep those innate immune receptors in check, and somebody had to trigger inflammation in that environment has does he do it? Well, it does sit through this amazing machine that Dan alluded earlier that
we discovered more than two decades ago. It’s an amazing sort of bacterial injection device if you will. That injects bacterially encoded proteins that. Have the capacity to modulate many signal transduction pathways. And it’s the ability to stimulate those signal transduction pathways and modulate cellular process for the benefit of the pathogen specifically relevant to inflammation are three of these effective proteins that activate Rho Family GTPases by either being exchange factors of
00:21:39.701 --> 00:21:42.501 the Pro Family GPs is or forcefully
NOTE Confidence: 0.858762
00:21:42.575 --> 00:21:44.029 nocetti phosphatase.
NOTE Confidence: 0.858762
00:21:44.030 --> 00:21:46.364 In the case of this particular
NOTE Confidence: 0.858762
00:21:46.364 --> 00:21:47.920 effector that wouldn’t activate
NOTE Confidence: 0.858762
00:21:47.987 --> 00:21:50.747 endogenous change factors and activate that,
NOTE Confidence: 0.858762
00:21:50.750 --> 00:21:54.230 and that leads to the activation of CDC.
NOTE Confidence: 0.858762
00:21:54.230 --> 00:21:56.462 42 and then the activation of CDC 42
NOTE Confidence: 0.858762
00:21:56.462 --> 00:21:58.079 leads to transcriptional responses
NOTE Confidence: 0.858762
00:21:58.079 --> 00:22:00.063 that really are proinflammatory
NOTE Confidence: 0.858762
00:22:00.063 --> 00:22:02.047 and really looked like
NOTE Confidence: 0.8360523
00:22:02.116 --> 00:22:03.109 in 18 responses.
NOTE Confidence: 0.8360523
00:22:05.350 --> 00:22:07.895 number of years because CDC 42 had
NOTE Confidence: 0.8360523
00:22:07.895 --> 00:22:10.157 never been linked to innate immune
NOTE Confidence: 0.8360523
00:22:10.233 --> 00:22:12.369 responses until very recently,
NOTE Confidence: 0.8360523
00:22:12.370 --> 00:22:14.722 where we sort of cracked this little
00:22:14.722 --> 00:22:17.013 puzzle and we discovered that the
00:22:17.013 --> 00:22:19.834 activation of CDC 42 by Salmonella leads
00:22:19.910 --> 00:22:22.334 to the formation of a noncanonical
00:22:24.618 --> 00:22:26.622 A target of CDC 42 and
00:22:26.622 --> 00:22:28.210 these other components.
00:22:28.210 --> 00:22:29.226 Trap 6 Tab Tak,
00:22:29.226 --> 00:22:32.097 One Tab 1 Tab 2 that leads to the
00:22:32.097 --> 00:22:34.217 inflammatory response and what is
00:22:34.217 --> 00:22:36.889 what explains the whole thing is
00:22:36.889 --> 00:22:38.641 that these signaling complexes
00:22:38.641 --> 00:22:40.651 identical to the signaling complex
00:22:40.651 --> 00:22:42.913 that is tripped by narimi receptors.
00:22:42.920 --> 00:22:45.286 So what someone in essence is doing
00:22:45.286 --> 00:22:47.365 is going down the signaling pathway
so that so as to avoid the negative regulatory system and trigger essentially an innate immune response. But by non Canonical methods, so he uses other type of mechanism similar to this going downstream of Canonical signaling pathways. But since my time is up I just gonna put up a sort of a summary of these and sort of to give you a flavor or how these effector proteins can go down. Different signaling pathways intersect with signaling pathway. For example this effector can activate the rig I and MD I5. A nucleotide sensing pathway,
but without the need of nuclear dice.

It just simply activates regay by interfacing with dream 56 and trim 65.

Two regulators of this pathway you.

We could make them activates them and trips this signaling pathway without the need of The Agonist of those receptors, and the same applies to another effector here that it actually inhibits an anti-inflammatory pathway.

So, but since I don’t have time. I had to skip it, so I hope that you got a sense of the sophistication by which bacterial pathogens manipulate cells in in ways
that benefit them but doesn’t benefit us.

And through the production of Gina toxins or inflammation, it leads to the predisposition to cancer and then finally last but not least, people that were involved in this work obviously and talked to work that was done a number of years ago as well, and thank you very much.

people that were involved in this work obviously and talked to work that was done a number of years ago as well, and thank you very much.
And with that I'm gonna stop sharing if I can.

And.

OK, well thank you very much.

Jorge is very interesting.

Very exciting work.

I don’t know how to swim.

I should know how to stop sharing but you help me on that one.

Yeah, OK.

If people have questions,

you can type them into the chat,

or Renee’s, or way to unmute them.

We can, if you’d like, sure.
I'm ask a quick question. I was very struck by that by what appears to be the convergent evolution of these two nuclease.

Yeah, it’s really very striking.

Is there? What is the advantage of the bacteria to induce cell cycle arrest?

What cell cycle arrest actually is also growing flammatory?

So probably one of the main drivers is the Pro inflammatory response and also in the case of some type is using this activity to target immune cells.

So obviously if you’re a virus and you know you know a thing or two about them and you integrate your
00:25:50.336 --> 00:25:52.882 genome in in the host, you’re free.

00:25:52.882 --> 00:25:53.890 You know you.

00:25:53.890 --> 00:25:55.846 That’s the way you can persist

00:25:57.590 --> 00:26:00.406 If you’re somebody that I feel you have.

00:26:00.410 --> 00:26:02.350 4761 those are the number

00:26:02.350 --> 00:26:03.902 of open reading frames,

00:26:03.910 --> 00:26:06.250 potential antigens you need to hide.

00:26:06.250 --> 00:26:08.190 You can’t do that right?

00:26:08.190 --> 00:26:10.542 So the way somebody that he does it

00:26:10.542 --> 00:26:13.633 is by creating a sort of immunological

00:26:13.633 --> 00:26:15.577 suppression around the site,

00:26:15.580 --> 00:26:17.132 wherein colonizes and these

00:26:17.132 --> 00:26:19.072 toxin is central for that.

00:26:19.080 --> 00:26:20.632 For the persistent infection,
00:26:20.632 --> 00:26:22.184 by targeting immune cells.
NOTE Confidence: 0.8003514

So, and in the case of Campylobacter,
NOTE Confidence: 0.8003514

of course,
NOTE Confidence: 0.8003514

inflammation is central for the bug and and
NOTE Confidence: 0.8003514

this proinflammatory aspect of DNA damage.
NOTE Confidence: 0.8003514

Is probably what evolutionary
NOTE Confidence: 0.8003514

selected for these,
NOTE Confidence: 0.8003514

you know,
NOTE Confidence: 0.8003514

toxins and the in the process.
NOTE Confidence: 0.8003514

We you know we got clipped.
NOTE Confidence: 0.83454424

Thank you are there
NOTE Confidence: 0.83454424

are there other questions for Jorge?
NOTE Confidence: 0.91647124

Alright, well thank you very much.
NOTE Confidence: 0.83337504

I think I think Dan froze.
NOTE Confidence: 0.83337504

You were frozen Dan.
NOTE Confidence: 0.83337504

Oh, I’m sorry, frozen.
I guess introduce you, Melinda Kay. Great don’t we love the advances in technology.

Thank you Doctor Glenn that was fabulous Ann.

I am now delighted to introduce Doctor Nicole Diesel to present her research on environmental carcinogens and thyroid cancer.

Doctor Diesel is an associate professor of environmental health in the Yale School Public Health and she received her PhD in her Masters in industrial hygiene from the Johns Hopkins School of Public Health. Her environmental exposure assessment...
strategies aimed to reduce exposure to environmental chemicals in the risk of cancer and other adverse health outcomes, and note that she is the winner of the Yale Cancer Center 2020 Research Prize in population science for her research on this topic.
so we’re delighted for your presentation.

Take it away.

OK, thank you so much Melinda for the generous introduction.

Very pleased to be here to share some of my recent work with you.

I really enjoyed Doctor Galanes presentation looking at exposure to microbial pathogens and the associated toxins, and I’ll be switching gears a little bit to look at work looking at the Epidemiology of exposures to chemical toxins and thyroid cancer risk.

OK, so I’ve advanced my slide and someone
can let me know if there's any issue there.

I first wanted to take a moment just to tell you about the motivation of my research and the research I'll be presenting today and talk about environmental risk factors for cancer. We know that third of cancers are attributable to modifiable factors. We often think of things related to diet, alcohol, tobacco, these so-called lifestyle factors. But this also includes infections which we just heard about as well as pollution. So how much of cancer cases can we attribute to this pollution?

While a doll and Peto in their landmark
A study estimated about 7% of cancer deaths could be attributable to occupation, pollution and industrial products, in many experts agree that this percentage is likely grossly. Under arrest Made due to the extremely limited data on the commercial chemicals that we encounter in our day-to-day lives. So in the United States there are 80,000 chemicals that are licensed for commercial use, and of those only 200. So not even a percentage of them have been screened adequately for carcinogenicity. And every time I share this statistic,
I find it really striking.

Another reason why this is so important is that you know many of these exposures are outside individual control.

These are things in air pollution or water supply, the food supply, our workplaces, so we really rely on the government to protect us from exposure to these potentially harmful chemicals and our regulatory system really is quite inadequate to serve this purpose. The way it’s structured.

Chemicals have to be proven harmful rather than proven safe at the outset,
so it normally requires researchers like myself and others in my fields who study chemicals you know for decades before we acquire enough evidence to demonstrate harm for particular chemical. And also importantly, we know these exposures are not distributed equitably across populations and that populations experiencing other social disadvantages are often disproportionately exposed to certain pollutants, and some of these points are highlighted in a forthcoming book chapter that I worked on with Doctor.
So turning to the specific research I want to talk about today, which is related to thyroid cancer, thyroid cancer is one of the fastest growing malignancy’s. It has nearly tripled over the past few decades. You can see in these graphs of SEER cancer incidence data. You can also know by looking at the Y axis that females have three times the incidence compared to males. Can thyroid cancer, you know, has a very good prognosis. It’s more than 90% survival after 20 years.
However, survivors face many physical, psychological and financial challenges. With the prolonged treatments, increased surveillance risk of second primary cancer and other quality of life issues. So this increase is likely certainly due at least in part to improvements and changes to diagnostic techniques, imaging techniques and an fine needle biopsy’s. So there’s some debate about what proportion can be attributed to this increased diagnostic scrutiny, but many analysis suggests that about half of this.
Trend can be linked to these diagnostic changes, leaving half for environmental or lifestyle factors. I’ve hypothesized that increasing exposure to thyroid hormone disrupting environmental chemicals such as these polybrominated diphenyl ether flame retardants or PVD ES may be partially driving this increasing trend. So I’ll just talk a little bit more about these people. These are actually a lot of thyroid hormone disrupting environmental chemicals in use in the environment. These flame retardants were widely added.
Too many different products.
The polyurethane foam in mattress is an couch, cushions and vehicle seats, including baby car seats. They were also added to electronics like phones, cell phones, televisions, computers and the reason they were added was to meet a flammability standards such that if these products you know caught fire they would burn. More slowly, which is a good thing from a public health perspective. However, these chemicals once added to these products,
did not stay bound in the matrices as indicated by their manufacturers and instead have migrated out into our homes. At home environments, cars, workplaces, etc. So due to this widespread use as well as disposal and improper disposal of these chemicals, they aren’t ubiquitous and more than 90% of the population here in the US and globally are exposed to these chemicals. And this also they are extremely persistent once they get into their homes or our bodies, they do not degrade very easily, so they stick around for years and decades. So due to concerns about this
00:35:50.444 --> 00:35:52.680 persistence and potential toxicities,
NOTE Confidence: 0.8233529
00:35:52.680 --> 00:35:55.480 these particular group of chemicals,
NOTE Confidence: 0.8233529
00:35:55.480 --> 00:35:58.505 the PDE’s were phase outs
NOTE Confidence: 0.8233529
00:35:58.505 --> 00:36:01.530 were initiated over the last.
NOTE Confidence: 0.8233529
00:36:01.530 --> 00:36:02.859 Past decade, however,
NOTE Confidence: 0.8233529
00:36:02.859 --> 00:36:04.631 exposures do continue for
NOTE Confidence: 0.8233529
00:36:04.631 --> 00:36:06.770 the reasons I described.
NOTE Confidence: 0.8233529
00:36:06.770 --> 00:36:08.016 Their persistence,
NOTE Confidence: 0.8233529
00:36:08.016 --> 00:36:09.262 you know,
NOTE Confidence: 0.8233529
00:36:09.262 --> 00:36:13.560 their presence in products made before then.
NOTE Confidence: 0.8233529
00:36:13.560 --> 00:36:16.104 As well as their presence in
NOTE Confidence: 0.8233529
00:36:16.104 --> 00:36:18.780 the food supply and elsewhere.
NOTE Confidence: 0.8233529
00:36:18.780 --> 00:36:21.066 One other group of chemicals that
NOTE Confidence: 0.8233529
00:36:21.066 --> 00:36:24.126 will be talking about today are the
NOTE Confidence: 0.8233529
00:36:24.126 --> 00:36:26.070 polychlorinated biphenyls or PCB’s.
NOTE Confidence: 0.8233529

58
These were also used widely in electrical equipment, hydraulic machinery, and construction materials. They were banned in 1979, so again, you might say why? Why are we even studying these now? Well, there's still around and they're still around in our bodies. Our bloodstreams in the environment, and in fact here in Connecticut, there's been some renewed concern about these legacy chemicals. They were commonly used in buildings, including schools constructed in the 1950s to 1970s.
and many of these schools now are in need of repairs and renovations, and there have been some notable schools in Connecticut that I’ve had PCB levels exceeding safe levels. Closures of schools you know, insufficient funds to do a proper and safe remodeling or renovations, and again, often these are in. Kind of environmental justice communities. So another reason to study these legacy chemicals is as they get phased out, new chemicals come to take their place, and many of those are also also have similar properties and so understanding.
These may help us inform greener chemistry or future regulations of other chemicals.

So we hypothesize that these PV East could be contributing to that increasing trend in thyroid cancer.

Here is a graph showing increasing exposure over a similar time period where we saw thyroid cancer cases start to go up.

You can see about a doubling every five years of these particular chemicals.

So looking at more recent data, these have been somewhat phased out.
You can see that well levels have come down since those some of those earlier years, but then they really have somewhat plateaued. Or are, you know some particular congeners of these? In this family of chemicals are still increasing slightly and we see similar. Trends with the PCB’s that levels have come down since they were banned, but then they reached this plateau in the population because of their persistence and then as new chemicals come on we may be introduced to those on top of these exposures.
Hey and so why?

Why do we think these may be linked to thyroid cancer?

These chemicals are established thyroid hormone disruptors.

Their endocrine disruptors and over here I have an image of our thyroid hormone thyroxine and then the PCB’s and the PVD ES and their general chemical structure so you can see immediately how structurally similar these chemicals are.

Shut thyrax, and we’ve got the two.

Aromatic rings and then while thyroxine has iodine, these chemicals have other halogens.
They have either chlorine or bromine’s. Just to further illustrate when for example this particular PDE gets metabolised, it gets this hydroxyl group added. And now even more closely resembles Thyrax in so the in vitro studies have shown that these chemicals can competitively binds with thyroid transport proteins and results in reduced circulation of thyroid hormones, which could then result in dysregulation of the transport and signaling pathways, potentially leading to Overproduction, of of hormones to compensate.
proliferation in the thyroid and potentially neoplasia.

So as you know the hypothalamus, pituitary, thyroid axis is this very well choreographed system. These perturbations or dysregulation of these systems can perhaps trigger some of these. I'm showing this slide to also illustrate that some chemicals have some additional hypothesized mechanisms, such as. Some have been shown to be capable to directly bind to DNA,
leading to mutations and could potentially lead to carcinogenesis that way.

So before we launched our study, there had only been two other studies examining this hypothesis. This idea that these PPDS could be linked to thyroid cancer. The first two rows of this table or the two prior epidemiologic studies in the third row was the study that I lead. A couple things to point out here is that the case is the studies that came before us had moderate study populations, and ours was larger. We also looked at more.
chemicals and importantly, we looked at single and multi pollutant models so. So what I mean by that is that in the real world you know we’re not exposed to one chemical at a time, where typically exposed to groups of chemicals or mixtures of chemicals and traditional environmental. Epidemiologic studies have looked at chemicals just one at a time, and in my work we’re looking at these so-called mixtures using different modeling techniques to look at the joint effect of exposures to multiple chemicals.
Similarly for the PCB’s, the other chemicals there were also only two previous studies before we did ours. Also the other studies were a bit smaller and we also looked at mixture modeling. One other one shortcoming, I wanted to point out actually in reference to at least one of the other studies is that our study was a case control study. So we did collect serum samples to do our. Environmental chemical measurements after diagnosis. Whereas one other study collected pre diagnosis samples, we think you know.
So we’re using this post diagnosis sample to try to capture exposures in the past. While it’s not optimal, we think this is actually a pretty strong and reasonable assumption, because we know that these chemicals have half lives of years and decades. Ends may well reflect past exposure. OK, so just a few more details about the study we conducted. I LED a study within a study and that larger study was the Connecticut thyroid cancer case control study, which was led by Yahweh Chung, who was our former colleague.
here at the Yale Cancer Center.

We focused on women because they have that three times higher risk.

I showed earlier about 90% of our cases were white, so we.

Focussed on the white population because our numbers were really small for looking at other demographics.

I do think now this is something I would like to follow up on more in another population.

we focused on papillary thyroid cancers.

That’s about 85% of the new cases or papillary.

We also collected very detailed
00:44:48.590 --> 00:44:50.180 information about demographics,
NOTE Confidence: 0.8271222
00:44:50.180 --> 00:44:51.158 lifestyle, diet.
NOTE Confidence: 0.8271222
00:44:51.158 --> 00:44:54.092 Many other risk factors that we
NOTE Confidence: 0.8271222
00:44:54.092 --> 00:44:56.620 can control for other factors.
NOTE Confidence: 0.8271222
00:44:56.620 --> 00:44:58.960 We collected the blood sample at
NOTE Confidence: 0.8271222
00:44:58.960 --> 00:45:02.190 the time of the interview and then
NOTE Confidence: 0.8271222
00:45:02.190 --> 00:45:04.830 measured the participants blood samples
NOTE Confidence: 0.8271222
00:45:04.830 --> 00:45:08.087 for 11 different peyizan 32 PCBS,
NOTE Confidence: 0.8271222
00:45:08.090 --> 00:45:10.958 which this analysis also gave us.
NOTE Confidence: 0.8271222
00:45:10.960 --> 00:45:12.856 Some pesticides like DDT,
NOTE Confidence: 0.8271222
00:45:12.856 --> 00:45:16.220 which are also structurally similar to these.
NOTE Confidence: 0.8271222
00:45:16.220 --> 00:45:19.388 And again we looked at both pollutants,
NOTE Confidence: 0.8271222
00:45:19.390 --> 00:45:22.127 one at a time, like like most studies
NOTE Confidence: 0.8271222
00:45:22.130 --> 00:45:25.586 do and then multi pollutant models.
NOTE Confidence: 0.8271222
00:45:25.586 --> 00:45:31.872 OK, so here’s some results from
our study population. These are factors that differed between cases and controls, so our cases had a lower educational attainment compared to controls. They did have a history of benign thyroid disease. That’s a strong risk factor for thyroid cancer. Alcohol consumption was actually higher, lower, lower in cases. This is one of the few cancers where alcohol actually has been consistently shown to have a protective effect.
An cases also had a history of thyroid cancer and higher BMI, which has been shown now in several studies indicating another possible risk factor that can also be interrelated to like endocrine disrupting chemicals and also.

OK, so here are some results from our single pollutant models where we looked at one chemical at a time. These are increasing categories of exposure within each of these different pollutants. You know, odds Ratio 1 means no effects, and anything above one would indicate an Association with thyroid cancer.
So you can see here that there’s really not much going on with these individual models. If anything, the odds of thyroid cancer seem to be lower than those who are exposed compared to the reference group of low exposure. The medium and high groups are not at an elevated odds of thyroid cancer except for this one chemical. So the medium and high groups are not at an elevated odds of thyroid cancer except for this one chemical.

This PB 153.

So when we move to our multi pollutant models, the results are also somewhat null.
00:47:31.598 --> 00:47:33.450 here using Bayesian modeling,
NOTE Confidence: 0.79854375
00:47:33.450 --> 00:47:36.216 which I won’t get into here.
NOTE Confidence: 0.79854375
00:47:36.220 --> 00:47:39.556 But here you can see that it’s the
NOTE Confidence: 0.79854375
00:47:39.556 --> 00:47:43.168 picture is still pretty null except for.
NOTE Confidence: 0.79854375
00:47:43.170 --> 00:47:46.404 In this case we have this other,
NOTE Confidence: 0.79854375
00:47:46.410 --> 00:47:49.030 a different chemical PDE 100.
NOTE Confidence: 0.79854375
00:47:49.030 --> 00:47:52.306 Was associated with elevated odds of
NOTE Confidence: 0.79854375
00:47:52.306 --> 00:47:55.730 thyroid cancer using both those models.
NOTE Confidence: 0.8645845
00:47:57.760 --> 00:48:00.888 And then finally we did this one more
NOTE Confidence: 0.8645845
00:48:00.888 --> 00:48:03.478 mixture type approach of principle,
NOTE Confidence: 0.8645845
00:48:03.480 --> 00:48:06.978 components analysis and in this work
NOTE Confidence: 0.8645845
00:48:06.978 --> 00:48:11.159 we found that people who had had this.
NOTE Confidence: 0.8645845
00:48:11.160 --> 00:48:14.796 Combination of exposures which was higher.
NOTE Confidence: 0.8645845
00:48:14.800 --> 00:48:19.280 PBDE 153. An lower PDE 209 had an
NOTE Confidence: 0.8645845
00:48:19.280 --> 00:48:22.669 elevated odds of thyroid cancer.
NOTE Confidence: 0.8226875
00:48:26.300 --> 00:48:29.850 So then moving on to the PCB use in this
for this one because we had so many chemicals. We had 32 different chemicals.

I'm just going to present some groups of structurally similar PCB's, which was another approach we used to look at groups of chemicals. So in this model this kind of we're just looking at one group at a time. Odds ratios are hovering around 1:00, so again pretty null findings. Not. We're not seeing a link between exposure and thyroid cancer. However, it said the most intriguing part of this study was when we took a closer look at the groups of people.
people who are exposed.

During who were younger during peak production, who were born during peak production of PCB’s.

So presumably would have their highest exposure in very early life. They consistently had higher odds of thyroid cancer, including this group of PCB’s that were particularly structurally similar to thyroid hormones, so this was quite intriguing to me, suggesting maybe the timing. Of exposure could be important.
some of the key takeaways from both. Of these studies. Strengths were that we looked at this larger population and incorporated these different models to account for Co exposure to multiple pollutants. The results were generally null. You know, we did see a few chemicals here and their associated with elevated odds of thyroid cancer. Particularly, this was more consistent when we looked at the group of women who were born during peak production of PCBS. However, this we only have 3 studies now.
For these, each of these groups of chemicals so. There's really insufficient evidence to rule them out, and I think there can be some improvements to the study design to try to look at this more carefully. I think looking at early life would be important, and using a prospective design where we could have samples collected pre diagnosis could help you know. Really, try to nail nail down if anything is going on here. And then finally I just want to talk
NOTE Confidence: 0.8235304
00:51:05.422 --> 00:51:08.618 about how where I’m taking this work.
NOTE Confidence: 0.8235304
00:51:08.620 --> 00:51:11.434 I have now expanded this work in
NOTE Confidence: 0.8235304
00:51:11.434 --> 00:51:13.690 adults to looking at children.
NOTE Confidence: 0.8235304
00:51:13.690 --> 00:51:16.228 So with my collaborator Xiaomei MA,
NOTE Confidence: 0.8235304
00:51:16.230 --> 00:51:19.184 also very active in the Cancer Center.
NOTE Confidence: 0.8235304
00:51:19.190 --> 00:51:21.305 We are looking at environmental
NOTE Confidence: 0.8235304
00:51:21.305 --> 00:51:23.420 exposures and pediatric thyroid cancer,
NOTE Confidence: 0.8235304
00:51:23.420 --> 00:51:25.112 so here’s some incidents.
NOTE Confidence: 0.8235304
00:51:25.112 --> 00:51:27.227 Data on pediatric thyroid cancer.
NOTE Confidence: 0.8235304
00:51:27.230 --> 00:51:30.184 It has also been increasing over time.
NOTE Confidence: 0.8235304
00:51:30.190 --> 00:51:32.360 An children are less likely.
NOTE Confidence: 0.8235304
00:51:32.360 --> 00:51:35.330 To be.
NOTE Confidence: 0.8235304
00:51:35.330 --> 00:51:37.070 Targeted for increased screening
NOTE Confidence: 0.8235304
00:51:37.070 --> 00:51:38.810 and diagnosis and imaging,
NOTE Confidence: 0.8235304
00:51:38.810 --> 00:51:41.420 so these trends are are concerning.
NOTE Confidence: 0.8235304
so we have some projects underway to try to look at environmental exposures in this more vulnerable population. And with that I would like to acknowledge all my wonderful collaborators and my funding from American Cancer Society as well as the Yale Cancer Center for getting me started in this line of research. Thank you. Thank you Doctor Diesel, that was fantastic. A little alarming. I would say when we start to think about how many you know, carcinogens exist in our environment.
in the fact that I’m intrigued by

the policy statement that we have to

show harm before anything can be done

and have these substances banned.

Do you think there’s any potential

to being able to reverse

that or change that policy?

Or will it take years and more data to do so?

Yeah, so a lot of the chemicals were kind

of grandfathered in when we established the

Environmental Protection Agency in 1970.

There is a new act that is supposed

to reverse this burden of proof,

but I don’t think it’s going to be

retroactive, so I am encouraged to with
the current administration that we may start to move towards a different model.

Also, in Europe they have stronger precautionary policies where if there's a safer alternative you have to use it. And you know not to wait until we prove something with certainty to take some sort of action.

Great, right? So there's a couple of chat questions I'll just quickly read them. Heard a Chow asked about any data on Agent Orange and thyroid cancer. Yeah, so Dioxin's is one of the constituents of Agent Orange. Well, Agent Orange.
00:53:36.540 --> 00:53:37.902 So various herbicides?

00:53:37.902 --> 00:53:39.900 And then? Dioxin’s

00:53:42.160 --> 00:53:43.660 that’s a great question,

00:53:43.660 --> 00:53:45.535 ’cause they’re also very structurally

00:53:45.535 --> 00:53:47.213 similar to the other chemicals

00:53:47.213 --> 00:53:49.208 I presented, but I’d have to,

00:53:49.208 --> 00:53:52.099 and some of the chemicals we looked at.

00:53:52.100 --> 00:53:56.160 Some of the groups were dioxin, like.

00:53:56.160 --> 00:53:58.687 I’m not, I’m not sure of any

00:53:58.687 --> 00:54:00.400 specific studies coming to mind,

00:54:00.400 --> 00:54:02.320 but it it seems likely that

00:54:02.320 --> 00:54:04.280 it may follow a similar.

00:54:04.280 --> 00:54:06.180 Well, they’re structurally similar

00:54:06.180 --> 00:54:08.990 to the other other chemicals. OK,

00:54:08.990 --> 00:54:11.100 great and then Jeffrey Townsend

NOTE Confidence: 0.7947095

NOTE Confidence: 0.81728315

NOTE Confidence: 0.81728315

NOTE Confidence: 0.81728315

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NOTE Confidence: 0.81728315

NOTE Confidence: 0.85703105

NOTE Confidence: 0.85703105
00:54:11.100 --> 00:54:14.129 has a question where you do see
NOTE Confidence: 0.85703105
00:54:14.129 --> 00:54:16.229 elevated odds of thyroid cancer?
NOTE Confidence: 0.85703105
00:54:16.230 --> 00:54:18.906 Do you have any evidence discriminating
NOTE Confidence: 0.85703105
00:54:18.906 --> 00:54:21.159 between the two hypotheses of
NOTE Confidence: 0.85703105
00:54:21.159 --> 00:54:23.553 effects that occur due to hormone
NOTE Confidence: 0.85703105
00:54:23.553 --> 00:54:25.237 disruption compared to effects
NOTE Confidence: 0.85703105
00:54:25.237 --> 00:54:27.751 that might be arising due to
NOTE Confidence: 0.85703105
00:54:27.751 --> 00:54:29.436 induction of carcinogenic mutation?
NOTE Confidence: 0.85703105
00:54:29.436 --> 00:54:31.140 Do you see ways
NOTE Confidence: 0.85703105
00:54:31.140 --> 00:54:32.844 to do this? Yeah,
NOTE Confidence: 0.85703105
00:54:32.844 --> 00:54:34.548 that’s a great question.
NOTE Confidence: 0.85703105
00:54:34.550 --> 00:54:36.870 I don’t really do this
NOTE Confidence: 0.85703105
00:54:36.870 --> 00:54:38.726 type of mechanistic work.
NOTE Confidence: 0.85703105
00:54:38.730 --> 00:54:41.100 I know the thyroid hormone
NOTE Confidence: 0.85703105
00:54:41.100 --> 00:54:41.890 disruption hypothesis.
NOTE Confidence: 0.85703105
00:54:41.890 --> 00:54:43.865 There’s been a lot more
mechanistic work in that area, but I’d be open to suggestions for how this could hopefully maybe inform some mechanistic studies. I think it would be, you know, I really think that. The study could inform mechanistic work and vice versa. Yeah, that’s a great great point. And then Ashida had mentioned in regards to the policy of showing harm that Europe does the reverse of the US. Do they see as a different trend? Actually, thyroid cancer cases
are going up globally and the

Actually, they were first observed

in Sweden where they have breast

milk banks and they saw these flame

retardants going up in human milk

samples which caused a lot of alarm.

At that time we didn’t know if

they were carcinogenic or not,

but given that you know babies were

going to be exposed to these chemicals,

that sort of.

Triggered this whole area of

research on these flame retardants

and other chemicals.

Great
and then I just have one final question. The email that we all received last week about benzene being in some of the hand sanitizers for COVID-19 protection? Do you have any thoughts or comments on that? Yeah, I read that. I read some of the materials. I think benzene is a known human carcinogen. However, it is present in many sources, so I would really want to understand how risky this is. I think we need to know how much. Benzene and how does that compare to putting gasoline in your car?
you know or being walking near the roadway

so I didn’t raise too many alarms yet,

but I would need.

I feel like I need more data to

be able to reach that conclusion.

And I mean, the so yell health,

environmental, safety and health

said like let’s be precautionary.

Let’s just get rid of these sanitizers,

you know, let’s take an action

before we have all the answers,

so I think that’s, uh,

you know, very sensible.

Approach OK great.

Well

thank you so much Dan.
Do you have any other closing comments? I'll just thank both our speakers today. Two terrific talks. I learned a lot. Thank you. Yes thank you. Have a great day. Thanks.